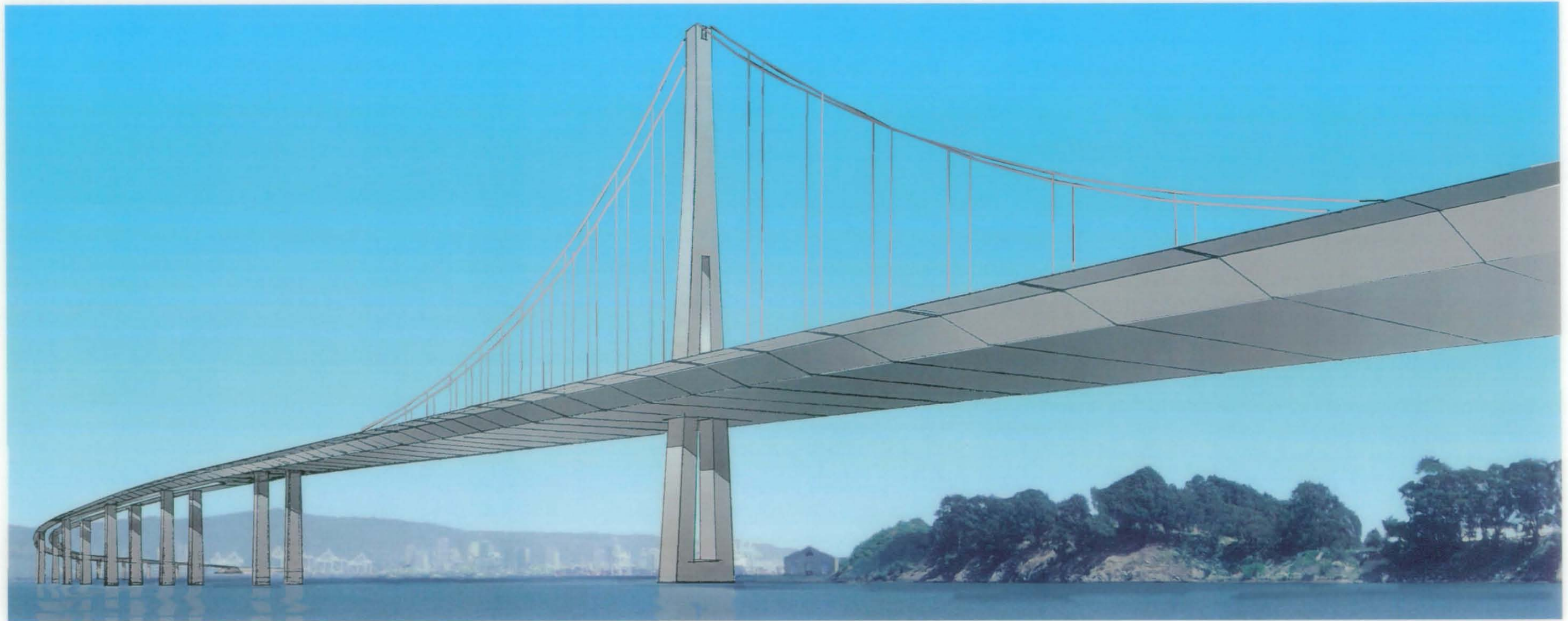


NEW EASTERN SPAN OF THE BAY BRIDGE • SELF ANCHORED SUSPENSION BRIDGE • WORKSHOP SUBMITTAL • MAY 1997

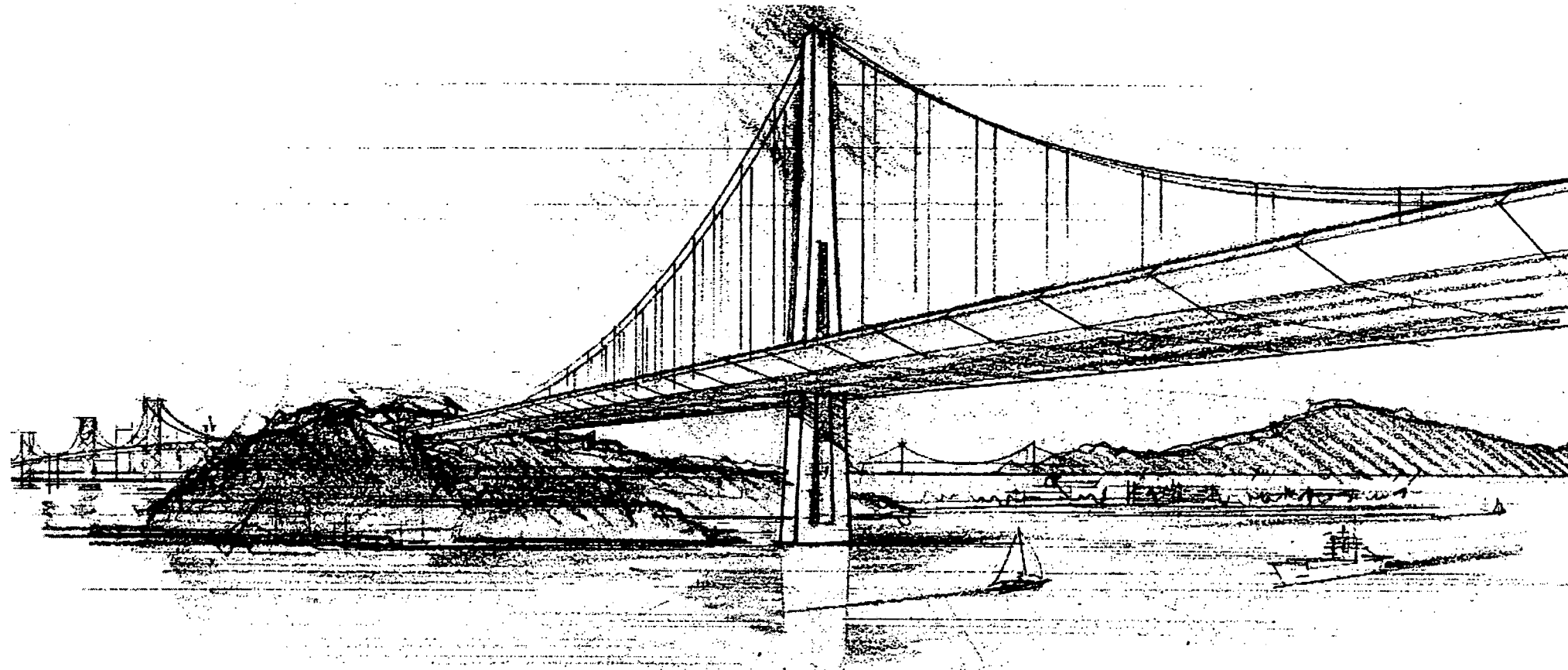


METROPOLITAN
TRANSPORTATION
COMMISSION



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INTRODUCTION

The present report is in response to the Metropolitan Transportation Commission's Bay Bridge Design Task Force request to receive presentations from interested parties on proposed designs for the new eastern span. It is understood that an Engineering and Design Advisory Panel (EDAP) has been convened to assist the Task Force in recommending a preferred design.

This report is submitted as a proposed design at the EDAP Workshop, May 12-14, 1997.

The current proposal has been developed by the Gerwick/Sverdrup/DMJM Joint Venture, currently working for Caltrans on the seismic upgrading design for the Richmond-Ran Rafael Bridge. Assistance has been provided by COWI, Ben C. Gerwick, Inc.'s parent organization, and Dissing & Weitling (Architects).

EXECUTIVE SUMMARY

ARCHITECTURAL

The Bayscape

The unique setting of the new Bay Bridge has been a major factor throughout the design process. Our design echoes the elegance and the sweeping lines of the Western Span as well as the Golden Gate Bridge. With their instantly recognizable profiles these bridges have become known around the world as the signature landmarks of the Bay Area. The new bridge complements the extremely sensitive Bayscape and provides a new landmark of its own right.

Design Approach

It has been a major concern to secure consistency in design in such a way that all constituent elements of the bridge, in spite of their different function and different structural principles form one whole. While a suspended main span was

obvious from an aesthetic point of view, the concept of a self-anchored bridge was a consequence of the difficult foundation conditions. However, the absence of anchor blocks has led to an unmatched lightness and elegance. This lightness is further emphasized by the slender single pylon that pierces the streamlined box girder.

Experience of Bridge Users

The new bridge will provide an exciting experience for its users. Motorists as well as cyclists and pedestrians will enjoy a magnificent panorama of the entire bridge. Driving along the long, sweeping curve of the viaduct, users will be given constantly changing views. The railing and crash barriers are designed for maximum transparency, while the pylon and suspension system placed in the middle of the girder allow unobstructed views throughout the bridge.

ENGINEERING

Overall Shore-to-Shore Concept

A complete shore-to-shore concept for a new East Bay Bridge running on an alignment north of the existing structure has been developed. Traffic emerging from the double-deck tunnel at the east portal will move onto a retrofitted tunnel portal structure. Traffic will then flow onto a new bridge which will transition to two parallel roadways leading to a self-anchored suspension bridge extending out over the bay. After crossing over the navigational channel drivers will move onto a gently curving viaduct leading to Oakland. A new pile-supported approach structure will take drivers down to the existing roadway.

Landmark Entrance to Oakland

The new self-anchored suspension bridge will be a landmark structure that creates a gateway to Oakland while remaining in harmony with the rest of the Bay's suspension bridges. The East Bay Bridge would become the first single-tower self-anchored suspension bridge and its scale would make it a unique world-class structure. The bridge will be designed using proven technologies marrying the elements of a classical suspension bridge with those of a modern cable-stayed bridge.

Reliable Seismic Performance

The post-earthquake performance of the new bridge will be excellent, as warranted by its lifeline status. By utilizing an innovative pier configuration all seat-type drop vulnerabilities have been eliminated. Only minor plastic hinging will occur in the supporting piers during the largest earthquakes. This hinging will limit the seismic demands imposed on the foundations and superstructure so they can ride out a major earthquake without damage.

CONSTRUCTION

Five Separate Construction Phases

The construction of the new eastern span of the Bay Bridge will have five separate phases, each utilizing special construction features. The five construction phases include:

- Main Span
- Curving Viaduct
- Transition Structure
- Tunnel Entrance
- East Approach & Abutment

Large Prefabricated Elements

The construction of the bridge in separate distinct phases implements several unique features which will allow for speed of erection and simplicity of construction. The construction of the main span involves the development of the foundations for the main tower and the four principal anchor piers. The piers will be prefabricated and floated to the site for full height erection. As a self-anchored suspension bridge needs temporary support prior to the cables being erected, a temporary support and skid system will be developed. The full size deck will be floated to the site on barges and erected by floating cranes, or on land, skidded into place. The girders will then be welded and the roadway deck cast. The main tower will then be erected. The pilot line will be installed and the cables erected. The load will then be transferred to the deck and the temporary supports removed.

Precast Concrete Piers

The viaduct spans will be supported on precast concrete piers which will be erected using heavy lifting equipment. The foundations for the viaduct spans will be constructed by floating in precast concrete caps and driving the steel pipe piles through the concrete pile. The steel piles will then be connected to the concrete cap using a tremie seal, rebar cages and plasticized concrete. The superstructure girders will be lifted into place and connected through closure pours. The girders will be connected across the piers through horizontal closure pours.

ENVIRONMENTAL

Wetlands Preservation

Our bridge protects the sensitive wetlands in the Emeryville Crescent by minimizing construction in this area. The eastern landing of the bridge is a pile-supported approach structure from open water onto shore to the west of the toll plaza. This is the most direct connection to the existing traffic lanes. A further advantage of this alignment is that it frees the area to the west of the connection for a variety of uses- including development for public access, excavation to the inter-tidal level to allow for reversion to wetland conditions, or even excavation to restore open-water conditions.

Minimize Dredging

Our bridge design and the construction procedures it contemplates will require the smallest practical amount of bay dredging and fill. Pile foundations for the piers will be placed with very little dredging. Construction procedures for shallow water areas will eliminate the need for access dredging. The use of long spans reduces the number of piers to the extent that removal of the old span will result in a net reduction of fill in the bay.

Nesting Sites

In terms of wildlife, horizontal beams in the design of the substructure of our bridge will allow for peregrine falcons and double-crested cormorants to continue their practice of nesting on the existing span.

COMMUNITY

Users of the Bridge

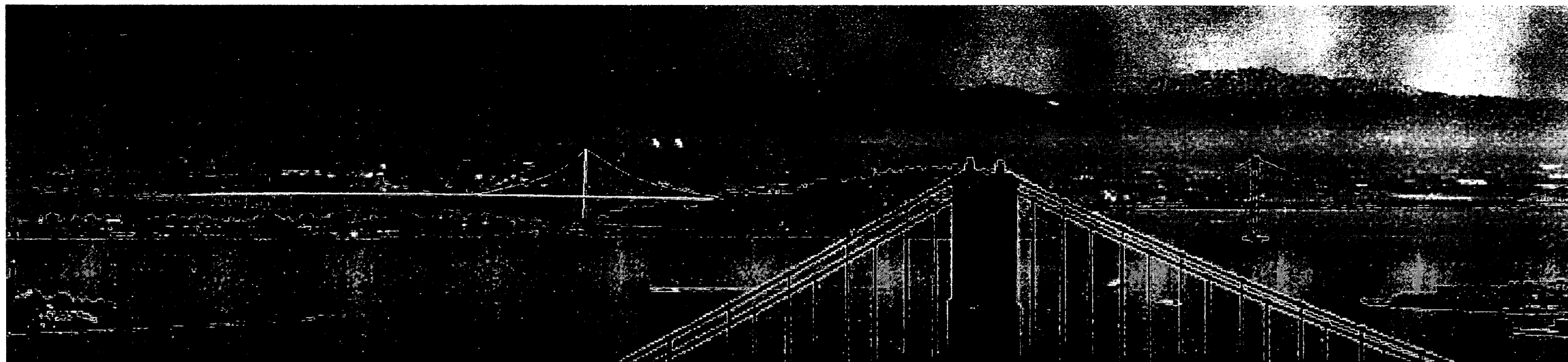
Users of the bridge will enjoy unparalleled panoramas of the bridge itself, the broad sweep of the bay, and the interactions of the bridge with the shorelines. Motorists will find their views ahead will be more open and their views to the sides unencumbered by the bridge and barrier structure. For the first time, motorists leaving the Yerba Buena Island tunnel and continuing along the span will enjoy an unimpeded view of the East Bay shoreline. Cyclists and pedestrians will find themselves on continuous viewing platforms separated from the main traffic flow. A temporary structure to the south of the existing span will allow for tie-in of the new bridge to the tunnel portal with almost uninterrupted flow of traffic.

Visual Environment

The new bridge presents a modern, vibrant visual statement while blending smoothly into the visual theme of the major bridges of the Bay. It gives the eastern span its own characteristic, instantly recognizable appearance while conforming to, and complementing, the visual themes of the other structures.

Performance

First and foremost, the new span will meet all of the stated criteria- it will provide a high level of post-earthquake performance; it will provide the required traffic lanes and shoulders within the stated slopes and geometry; it will merge smoothly with the tunnel and toll plaza, provide access to YBI, and provide for the specified navigation channel. Furthermore, it meets these goals with sensitivity to visual, aesthetic, and environmental concerns. We believe it is an elegant solution.



ARCHITECTURE

The unique setting of the new Bay Bridge has been a major factor throughout the design process. Our design echoes the elegance and the sweeping lines of the Western Span as well as the Golden Gate Bridge. With their instantly recognizable profiles these bridges have become known around the world as the signature landmarks of the Bay area. The new bridge complements the extremely sensitive Bayscape and provides a new landmark of its own right.

The design is unique, yet based on well-proven technology and is a synthesis of functional, technical, and economical as well as aesthetic requirements. It has been a major concern to secure consistency in design in such a way that all constituent elements of the bridge, in spite of their different function and different structural principles form one whole.

While a suspended main span was obvious from an aesthetic point of view, the concept of a self-anchored bridge was a consequence of the difficult foundation conditions. However, the absence of anchor blocks has led to an unmatched lightness and elegance. The lightness is further emphasized by the slender single pylon that pierces the streamlined box girder.

The main span has a single girder, the weight of which is visually reduced by the bicycle and walkways, which are cantilevered below road level. It merges smoothly with the viaducts twin girders which have the same depth throughout the bridge and the same inclined undersides. The new bridge will provide an exciting experience for its users.

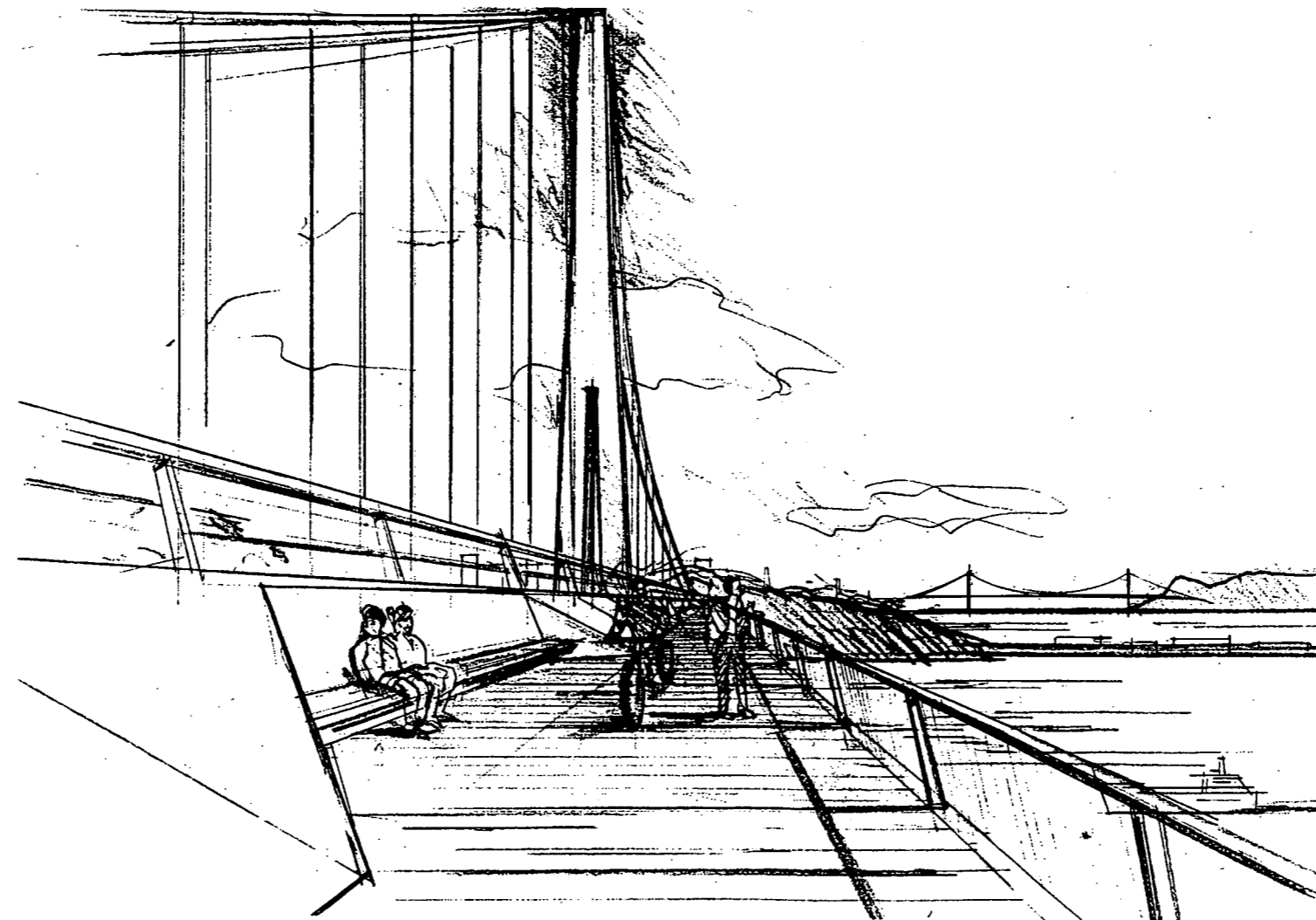
Motorists as well as cyclists and pedestrians will enjoy a magnificent panorama of the entire bridge while approaching it. Driving along the long, sweeping curve of the viaduct, users will be given constantly changing views. Motorists can overview the traffic at a greater distance, which helps to reduce discomfort at peak flow periods. Further, the monotony of driving in a straight line is avoided.

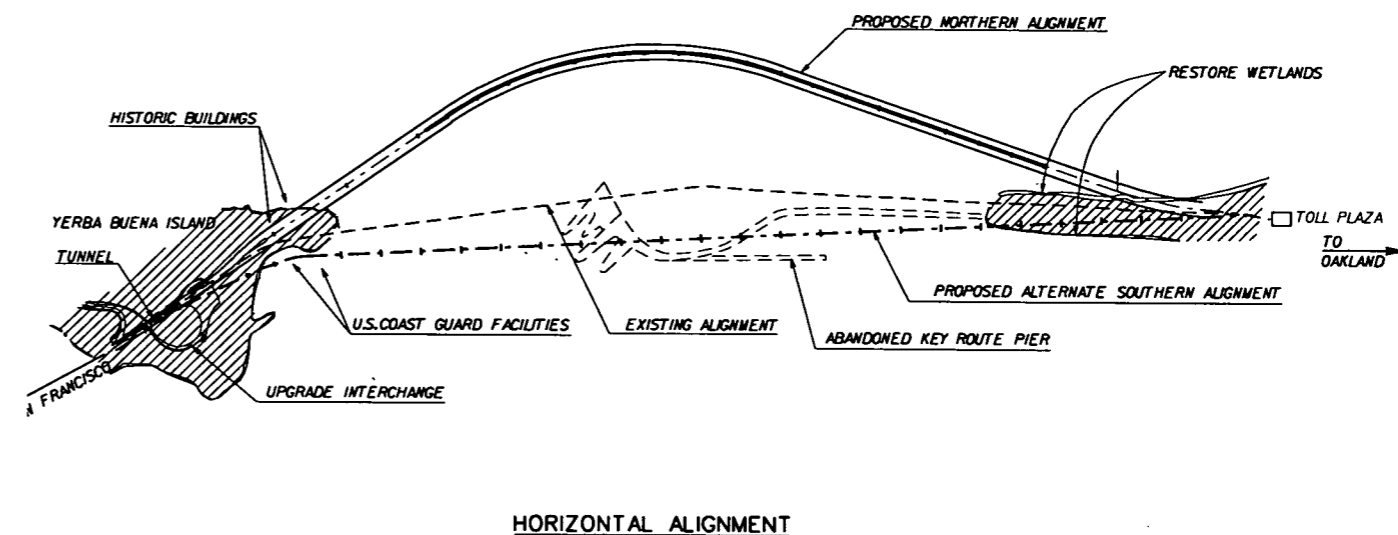
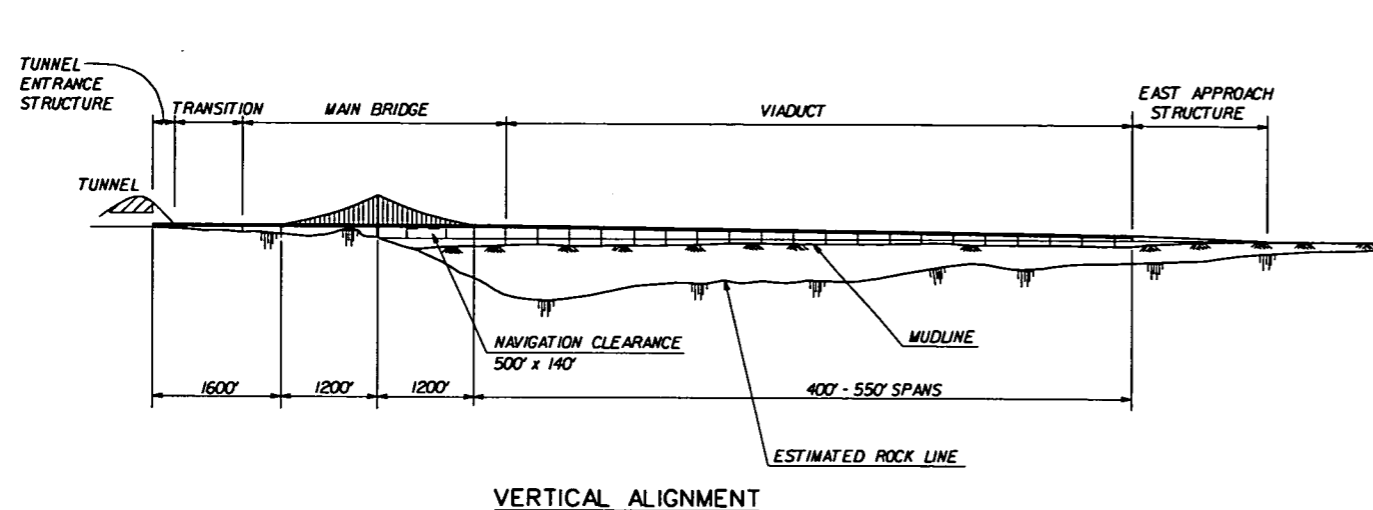
The railing and crash barriers are designed for maximum transparency, while the pylon and suspension system placed in the middle of the girder allow unobstructed views throughout the bridge.

The main span is clearly emphasized by the structures above the roadway, and the slot between the twin girders of the viaduct gives a view of the piers of the adjacent girder and the water below, thus providing an exciting feeling of being on a bridge.

The bicycle and walkways are placed at a lower level than the roadway. This improves the view from the roadway and more importantly gives the cyclists and pedestrians a feeling of protection. The cycle- and walkway will be a continuous viewing platforms where unique panoramas of the Bay can be enjoyed from seating niches recessed in the bridge girders.

The new landmark of Oakland will be an important improvement of the visual environment. It will be visible to hundreds of thousands of people, not only in the daytime, but also at night





ENGINEERING

GENERAL ARRANGEMENT OF PROPOSED BRIDGE

Northern Alignment

The proposed bridge will run on an alignment north of the existing bridge. When heading out of the double deck Yerba Buena Island tunnel towards the East Bay, eastbound traffic will continue along the same axis as the tunnel while the westbound deck descends and curves first to the left and then to the right until the two decks are running in parallel to one another. The two decks will continue along a tangent alignment before joining to cross the new long span structure that extends out over the Bay just east of the island. The new main bridge will provide a vertical navigational clearance of a 140 feet. After traversing the main bridge the two decks will separate and gently curve to the right towards Oakland and gradually descend reaching the coast just west of the existing toll plaza.

Bridge Layout and General Features

The bridge can be divided into five distinct sections that have been architecturally and structurally united; the main bridge, the curving viaduct, the tunnel entrance structure, the transition structure on Yerba Buena Island, and the east abutment and east approach structure. The decks of the main bridge, viaduct, and east approach structure will have five 12-foot traffic lanes, a 4-foot inside shoulder, and a 10-foot outside shoulder. The transition structure while having five lanes will have shoulder widths that diminish to match the tunnel entrance structure and the tunnel itself. All four sections will have 8-foot pedestrian/bicycle facilities that are placed below the roadway deck on the outsides of the bridge giving motorists, pedestrians, and bicyclists an unobstructed view of the Bay. Traffic barriers will be constructed using tubular steel rails so they are as transparent as possible thereby enhancing visual sight lines. Light standards will be placed on the inside edges of the bridge to avoid obstructing views to the north and south.

The post-earthquake performance of the structure will be excellent as warranted by its lifeline

status. Bridge seat-type drop vulnerabilities have been eliminated by using integral connections between the deck girders and supporting piers. Bridge bearings have been eliminated by using flexible "split piers" that can accommodate the thermal movements of the bridge at the intermediate expansion joints. Except for possible minor damage at the deck expansion joints, the superstructure will remain elastic and undamaged. Damage at the expansion joints will be controlled through the use of transverse lock-up mechanisms and hydraulic viscous dampers which will tend to reduce longitudinal displacements during an earthquake. Only minor plastic hinging will occur in the supporting piers during the largest earthquakes. This hinging will limit the seismic demands imposed on the foundations and superstructure so they can ride out an earthquake without damage. No damage will occur in the inaccessible foundations. Any structural damage that occurs will be in the supporting piers below the decks and above the highest tide so that it can be easily detected and repaired.

The bridge design employs large structural elements that can be prefabricated for rapid erection at the site. This will reduce construction disturbances to the Bay and to the local community. For example, it is envisioned that the full-width box girders for supporting the viaduct will be erected full length by floating them in on barges or by using heavy lift equipment. The piers will be prefabricated for full-height erection. Footing blocks will consist of precast concrete caissons that can be floated into position and lowered below water so that they can be used as templates for placing large tubular steel piling before final concreting. All prefabricated elements will be joined using cast-in-place concrete with continuous (coupled) mild reinforcement and prestressing. The use of prefabricated elements will enhance the quality and durability of the completed bridge, and it will improve the safety of the workers and inspectors during construction.

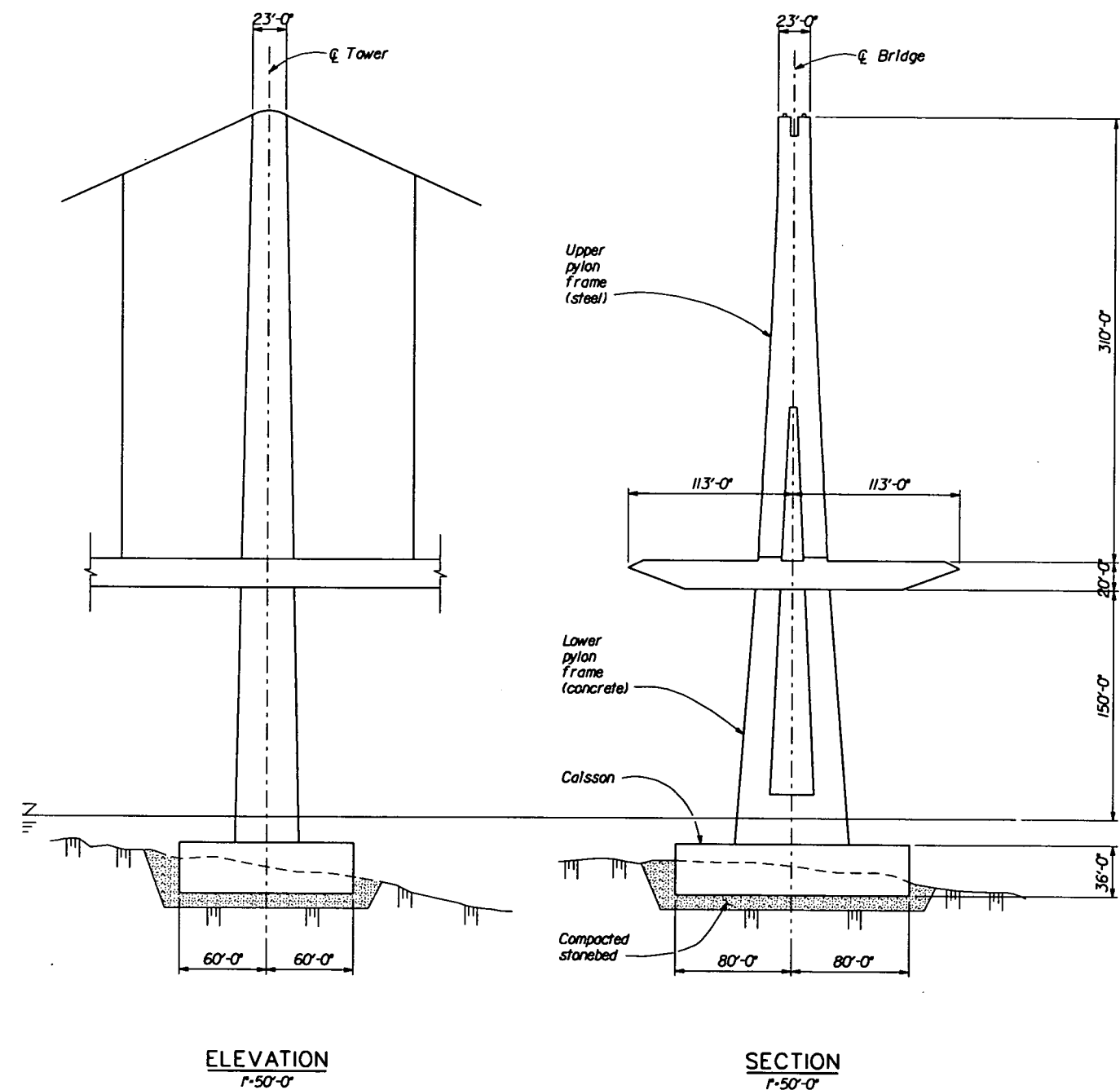
MAIN BRIDGE

General Layout

The main bridge is designed as a single-tower self-anchored suspension bridge with two equal spans of 1200 feet and side spans of 475 feet, for a total length of 3500 feet. The East Bay Bridge would become the first single-tower self-anchored suspension bridge and its scale would make it a unique world-class structure.

The cable sag to span length ratio has been chosen higher than normally applied on suspension bridges to reduce the main cable force. The 480-foot tall tower, however, is compatible with the height of the West Bay Bridge.

The bridge deck is continuous over the two cable supported spans and the two adjacent spans. The deck is supported every 66 feet by hangers fixed to the two main cables that are spaced 25 feet apart. The closed box girder has sufficient torsional stiffness to be supported



only at the pylon and adjacent piers. The integral connection between the deck and the pylon is sufficiently rigid to resist all applied loadings.

The integral pier to girder connections further improve the seismic behavior of the bridge. Temperature variations are taken by bending in the slender back-span piers. This elimination of expansion joints reduces the level of required maintenance and enhances redundancy and reliability consistent with the objective of maintaining lifeline service.

Self-anchored suspension bridges have in the past been disregarded because the deck has to be temporarily supported while the cables are erected. This disadvantage is more or less eliminated by using large prefabricated elements that reduce the number of temporary supports required.

A self-anchored suspension bridge is a proven technology that marries the structural elements of a two-tower anchor-block-supported suspension bridge and a cable-stayed bridge. A self-anchored two-tower suspension bridge with a main span of 800 feet is currently under construction in South Korea as part of the new airport at Yongjong. The bridge will carry ten lanes of traffic and a dual railway for mass transit.

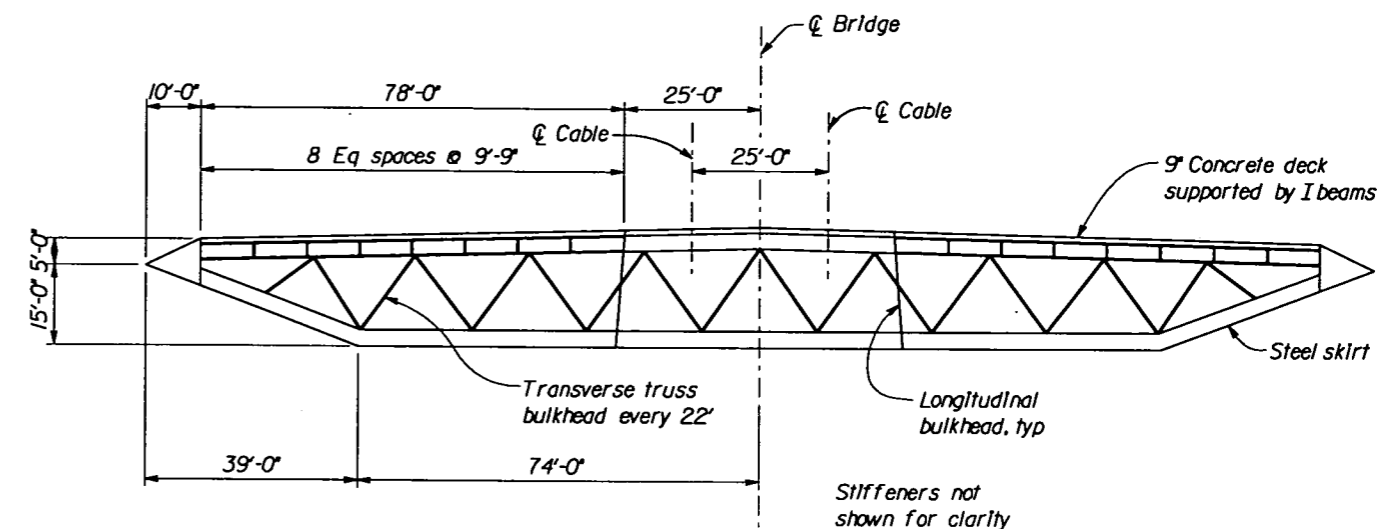
A traditional suspension bridge with anchor blocks would be more costly compared to a self-anchored suspension bridge because of the poor foundation conditions in the Bay. An anchor block founded in deep bay mud would either have to be supported on a large number of long robust piles or alternatively on a deep caisson. In either case, an expensive structure, vulnerable to seismic forces due to excessive mass, would result.

Cable System

The main suspension is composed of two cables spaced 25 feet apart, each with a diameter of 2½ feet. The cable can either be fabricated by air spinning or using prefabricated strands depending on the preference of the contractor.

Each cable consists of 32 strands. The number has been chosen to provide a relatively simple arrangement of the main cable anchorage in the girder. After entering the box girder the main cable goes through a splay saddle and the strands are spread and anchored 120 feet behind the splay saddle. Over the tower the main cable is supported on a tower saddle.

The cable supports the deck every 66 feet by two pairs of hangers with pinned connections at both the girder and cable clamps. The bridge will be designed such that one hanger can be replaced without any traffic restrictions. In the unlikely event that the hangers are damaged in an accident, two adjacent hangers can be replaced with only minor traffic restrictions.



MAIN BRIDGE CROSS SECTION

1" = 20'

Bridge Deck

The bridge deck is outlined as a fully welded closed steel box girder with a composite lightweight aggregate concrete roadway deck. The main advantages of the proposed layout is low weight, high torsional stiffness, good aerodynamic performance, suitability for mass production, and the possibility of corrosion protection by dehumidification.

Two longitudinal bulkheads, with the same inclination as the outer pylon are provided. The multi-cellular cross section increases the torsional stiffness even further.

The cross section is arranged with a skirt of orthotropic plates composed of plate and trough stiffeners for the sides and bottom of the box. The roadway deck in lightweight concrete is supported on longitudinal beams spaced approximately 10 feet on center. Alternatively, the concrete deck plate could be cast on a continuous stiffened steel plate. The concrete and steel plate would be made composite through the use of shear studs. This would allow for a thinner concrete deck thus reducing weight.

Transverse bulkheads are provided every 22 feet to support the longitudinal beams and the stiffeners. The transverse bulkheads are constructed using a truss system.

The hangers are anchored in the bottom of the girder to ensure an adequate length for the hanger as the main cables approach the box girder. The hanger forces are introduced in the cross section through the trussed bulkheads.

The girder is fixed to the pylon by headed studs welded on the steel. Post-tensioning cables will be provided to ensure composite action between the pylon and girder.

The shape of the cross section is similar to the cross sections utilized on recent European suspension bridges, where wind tunnel tests and aerodynamic simulations have proven excellent aerodynamic performance with low drag.

The interior of the box girder will be corrosion protected by dehumidifying the interior. By keeping the relative humidity of the interior air below 60% no corrosion will occur and substantial savings, both in fabrication and maintenance, can be obtained.

Pylon

The pylon is the focal point of the self-anchored suspension bridge, both visually and structurally. The pylon is an A-frame with a cross beam composed by the bridge girder. The pylon, up to girder level and including the cross beam inside the girder, consists of reinforced concrete. The top part of the pylon is envisioned to be constructed in steel, anchored by post-tensioning bars in the cross beam. This ensures quick erection and reduces the mass of the tower.

Foundations

The bedrock layer east of Yerba Buena Island drops rapidly to an elevation of about -300 feet at a distance of only 1000 feet from the island. The water depth increases to about 80 feet within the same distance. The location of the foundation for the main suspension bridge tower is therefore carefully chosen where the subsurface rock conditions and water depth make the foundation both economical and seismically adequate. The water depth and depth to rock is approximately 40 feet at the chosen foundation site.

Prior to placing the 120 feet long and 160 feet wide foundation caisson the top 30 feet of bedrock will be removed and a layer of dense aggregate backfill material will be placed on top of the bedrock to form a leveled seat for the caisson.

The 36 foot high multiple cell concrete caisson will either be prefabricated, floated to the site and lowered into place, or cast-in-place inside a cofferdam, depending on the preference of the Contractor. For the float-in option, cofferdam walls will be placed on top of the caisson walls to facilitate dewatering the caisson after a concrete tremie seal has been placed. The main tower legs can then be connected to the caisson in the dry.

The foundation is sized so that only minor inelastic deformation of the soil (rocking) is expected. The concrete caisson will perform linear-elastically without any damage during a major seismic event. Any plastic deformation will occur in the concrete legs above water.

Fenders extending above water will be provided adjacent to the navigational opening and at adjacent viaduct piers. The actual number will be decided by the U.S. Coast Guard, but it is anticipated that they will be required over the same expanse of water that is currently protected by fenders at the existing bridge.

Seismic Performance

The fundamental periods of vibration for the main bridge are relatively long, as can be expected for a cable suspension structure. Transverse and longitudinal periods of vibration are approximately two seconds, which is ideal for a structure supported on rock. At five percent damping, the structure has a relatively low-level response to seismic input motions. Demands are in the 0.5g range. The introduction of dampers at the expansion joints will increase the level of damping making it possible to design the bridge to respond elastically in the longitudinal direction. Displacement ductility demands at the base of the pylon can certainly be kept less than 1.5 in this direction.

The inelastic behavior of the pylon in the transverse direction will take place in the legs below the deck and above the foundation stiffening element which is above water. The pylon legs just below the deck girder will be designed to ensure that plastic hinging is confined to the legs only. This will prevent inelastic deformations from occurring in the deck girder itself. Under a transverse seismic loading the trailing leg (tension side) forms plastic hinges at the foundation and deck level while the leading leg (compression side) remains elastic. The imposed displacement ductility demands are of the order of 2.0.

Vertical post-tensioning may be required to enhance the shear capacity in the trailing leg under transverse seismic demands. This post-tensioning will be arranged about the neutral axis of the section in a manner that will optimize the response of the pylon. The pylon's steel section above the deck girder and the deck girder itself will remain elastic.

VIADUCT

General Layout

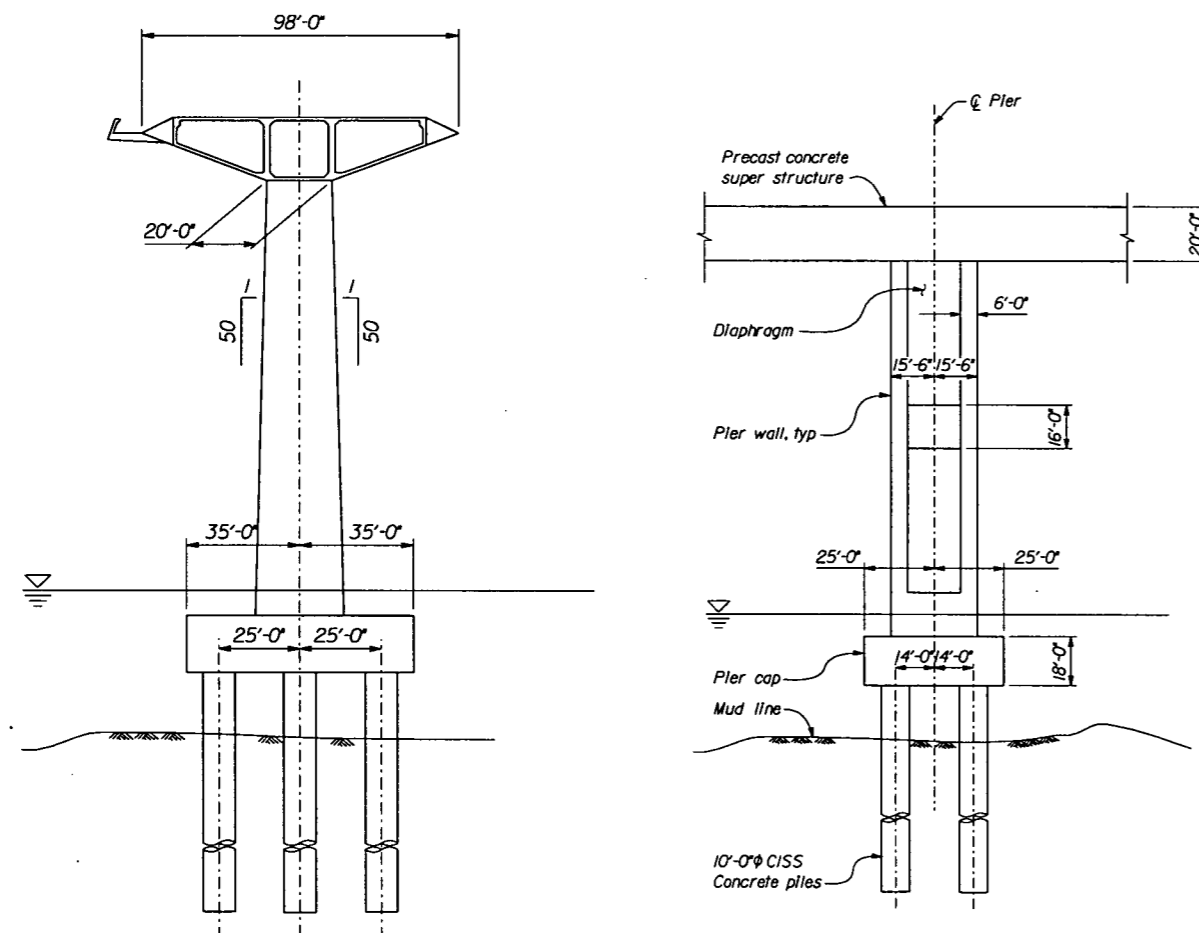
The viaduct roadways are supported on constant depth, trapezoidal post-tensioned concrete box girders supported on concrete piers that are evenly spaced for the full distance between the main bridge and the east approach structure. Uniform spans of 475 feet are envisioned. The depth and shape of the girders will match the 20-foot deep main span girder. This uniformity improves the efficiency of the prefabricated units and enhances the visual orderliness of the bridge.

The piers are constructed using two walls spaced 25 feet apart that are placed perpendicular to the bridge centerline. They are interconnected by a stiff centrally located beam at mid-



height. When seen in elevation the walls will have a constant thickness of six feet. When viewed in section, the walls have a slight taper so that they increase in width as they descend toward the water. They have a 20 foot top-width to match the girder soffit. The horizontal beam will be removed at the expansion piers to form a "split pier" for accommodating temperature fluctuations. The split eliminates the need for bridge bearings which improves the reliability of the structure by eliminating potential drop failures.

The pier walls are supported on footing blocks submerged below water. This enhances the appearance of the structure by removing the massive concrete blocks from the Bay view. Submerging the blocks up to ten feet below water does not overly complicate the foundation construction. Cofferdam walls can be attached to the prefabricated caissons prior to float-in.



ELEVATION
1" = 30'-0"

SECTION
1" = 30'-0"

Once the steel tubular piles are driven, a concrete tremie seal can be placed to allow de-watering for reinforcement and concrete placement. The cofferdams walls are removed at the end of the footing construction.

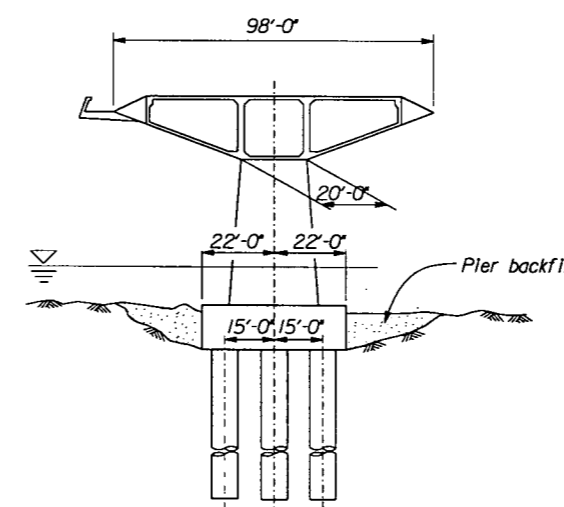
Material Selection

Lightweight aggregate concrete will be used to construct both the box girders and the footing blocks. Reducing the overall mass will improve the structure's seismic response and will reduce the weight of the prefabricated elements to be erected. The reduced mass will also reduce the service load demands imposed on the foundations. Constructing the viaduct in precast concrete will greatly reduce the level of maintenance required, especially when compared to the existing bridge.

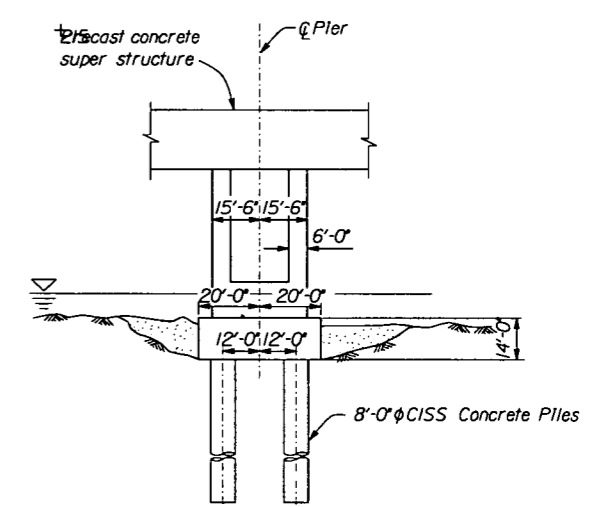
Foundations

The foundations supporting the viaduct piers will be supported by cast in steel shell piling ranging from 10 foot diameter piles east of the suspension bridge to 7 foot diameter piles toward the east abutment. The water depth at these foundations ranges from 40 feet to only 1 foot (MLLW). Cofferdams can therefore be utilized for the foundations close to the east abutment.

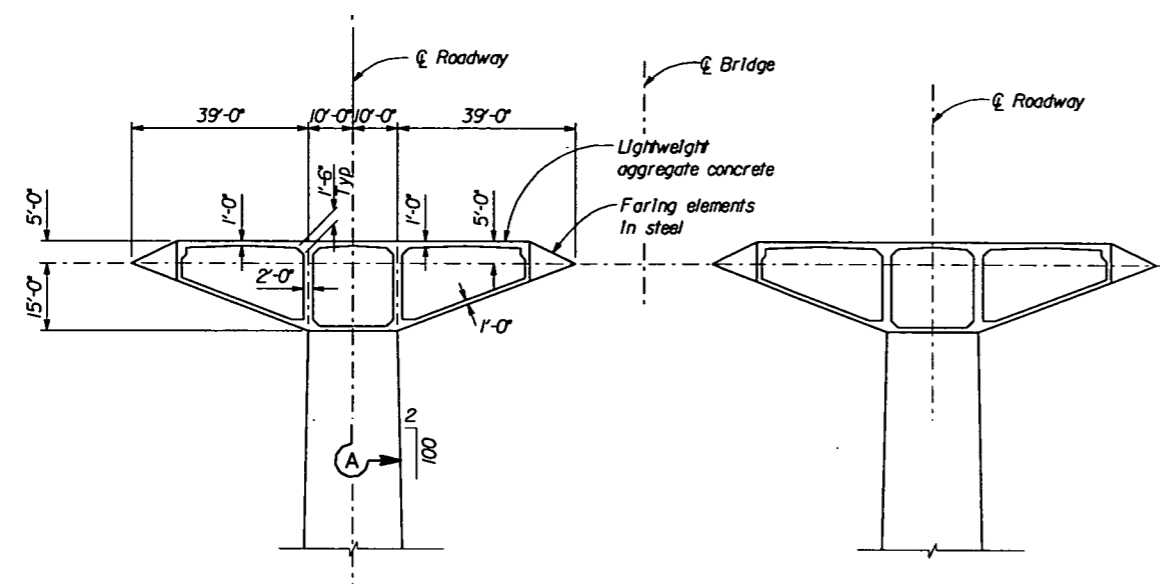
The precast concrete pile cap, up to 50 feet long, 70 feet wide, and 18 feet high, will be float-



SECTION
1" = 30'-0"



ELEVATION
1" = 30'-0"



VIADUCT BRIDGE CROSS SECTION
I = 20'

ed into place where the water depth is eight feet or greater at high tide. The pile cap shell will be sunk down onto temporary falsework piling such that the top of the pile cap is about six feet below MLLW. This ensures that the pile cap will never be visible even during extreme low water. Minor dredging at the shallow locations will be required. The steel shells can then be driven using the pile cap as a template. Temporary cofferdam walls attached to the pile cap shells combined with a tremie seal course allows for dewatering of the pile cap and construction of the cap to pile connection in-the-dry.

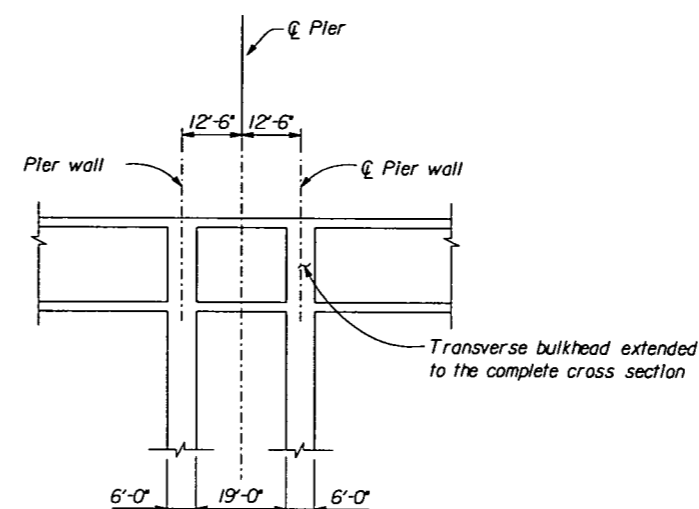
The foundations are designed to remain elastic and deflect 12 inches horizontally during a major seismic event. Any non-linear deformation will occur in the concrete piers above water.

The pile length typically ranges from 140 feet to about 220 feet. The top 40 feet of the piles will be filled with structural concrete to provide an adequate development length of the pile dowel reinforcement. However, at the option of the Contractor, the concrete in the lower part of the piles can be eliminated by increasing the wall thickness of the steel shells.

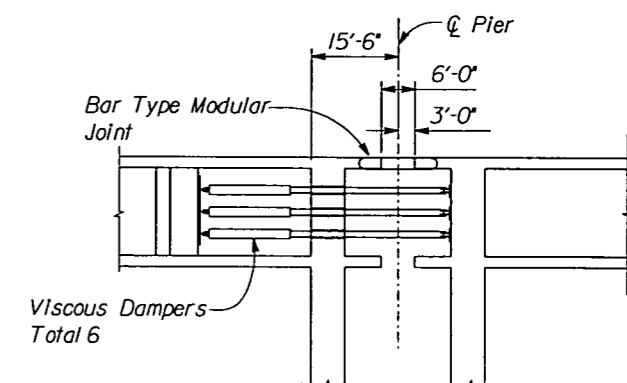
Seismic Performance

The chosen pier configuration allows the structure to be "tuned" for optimal seismic performance. This is achieved by balancing pier stiffnesses as the height of the structure or the foundation response varies. This can be accomplished in several ways:

- by removing the mid-height horizontal beam

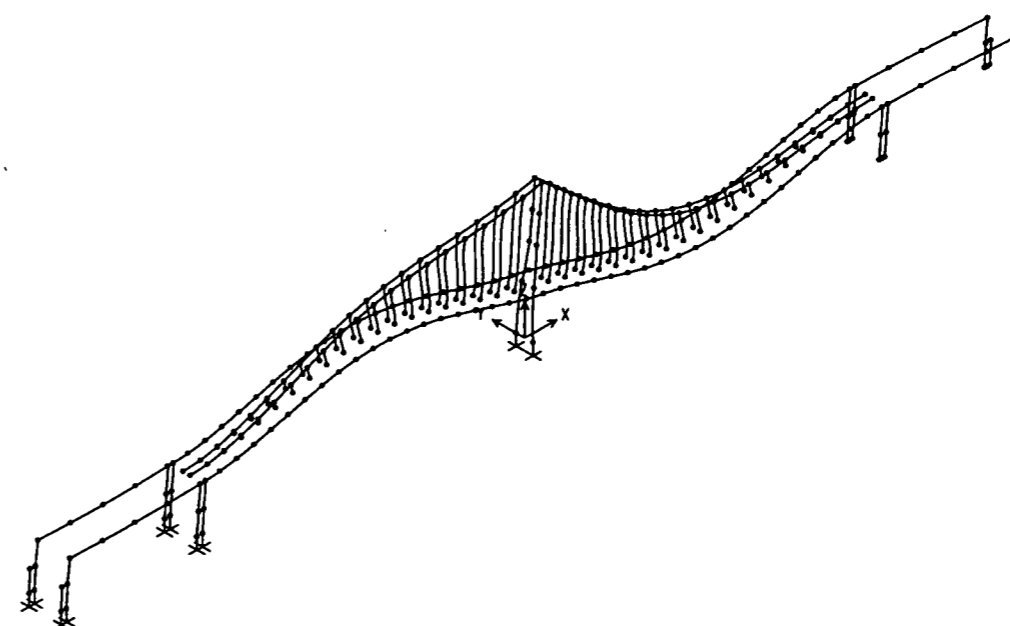


SECTION A-A
I = 20'



SECTION A-A AT EXPANSION PIER
I = 20'

- by placing a concrete hinge mechanism at the top of the walls
- by varying the thickness of the walls
- by using only a portion of the entire wall width



Analyses have shown that by utilizing the above techniques the displacements caused by earthquake motions can be maintained within acceptable limits. Displacement ductilities will be kept between 2 and 3. Except for the expansion joint assemblies, all earthquake damage that occurs will be below the girder and above water for quick post-quake surveillance and repair. The split piers ensure reliability by eliminating bridge bearings which can become unseated. Viscous dampers placed at these joints will prevent damage due to impacting further ensuring structural reliability. The structure will be ready to receive traffic almost immediately after an earthquake.

TRANSITION STRUCTURE AT YERBA BUENA ISLAND

The transition structure at Yerba Buena Island runs between the tunnel entrance structure and the main bridge, shifting traffic from a double deck roadway configuration to parallel single deck roadways. It will be constructed after traffic has been shifted over to a temporary bridge running on the south side of the existing alignment. Eastbound traffic exiting the tunnel will run straight out onto the transition structure and further on to the main bridge. Westbound traffic leaving the main bridge will rise up and over to align with the existing tunnel.

The eastbound roadway, which is on grade coming out of the tunnel, will run directly onto a box girder spanning over the island's steeply sloping hillside. This girder will be an extension of the back-span girders of the main bridge.

Westbound traffic will also be carried on a full-size box girder until reaching the top of the sloping hillside. It will then transition to a shallower cast-in-place post-tensioned concrete box girder bridge before extending over the lower roadway in order to meet minimum vertical clearance requirements. This concrete box girder bridge will have much shorter spans as compared to the rest of the bridge. Out-rigger bents will be required to complete this transition.

The foundations for the transition structure will mostly be spread footings. Piled foundations may be required at a few locations. This structure will have a seismic design consistent with the rest of the structure.

EAST ABUTMENT AND APPROACH STRUCTURE

After passing through the existing toll plaza, westbound traffic is currently funneled into five lanes of traffic while turning towards south. The proposed northern alignment takes advantage of the existing alignment by tying into the roadway north-west of the toll plaza, resulting in the new alignment having only a slight turn towards the north.

The elevation of the roadway at the toll plaza is only a few feet above sea level. In order for the roadway to tie into the first 20-foot deep viaduct span, an 1800-foot long approach structure is required. The roadway will ramp up at a maximum grade of 2.74%.

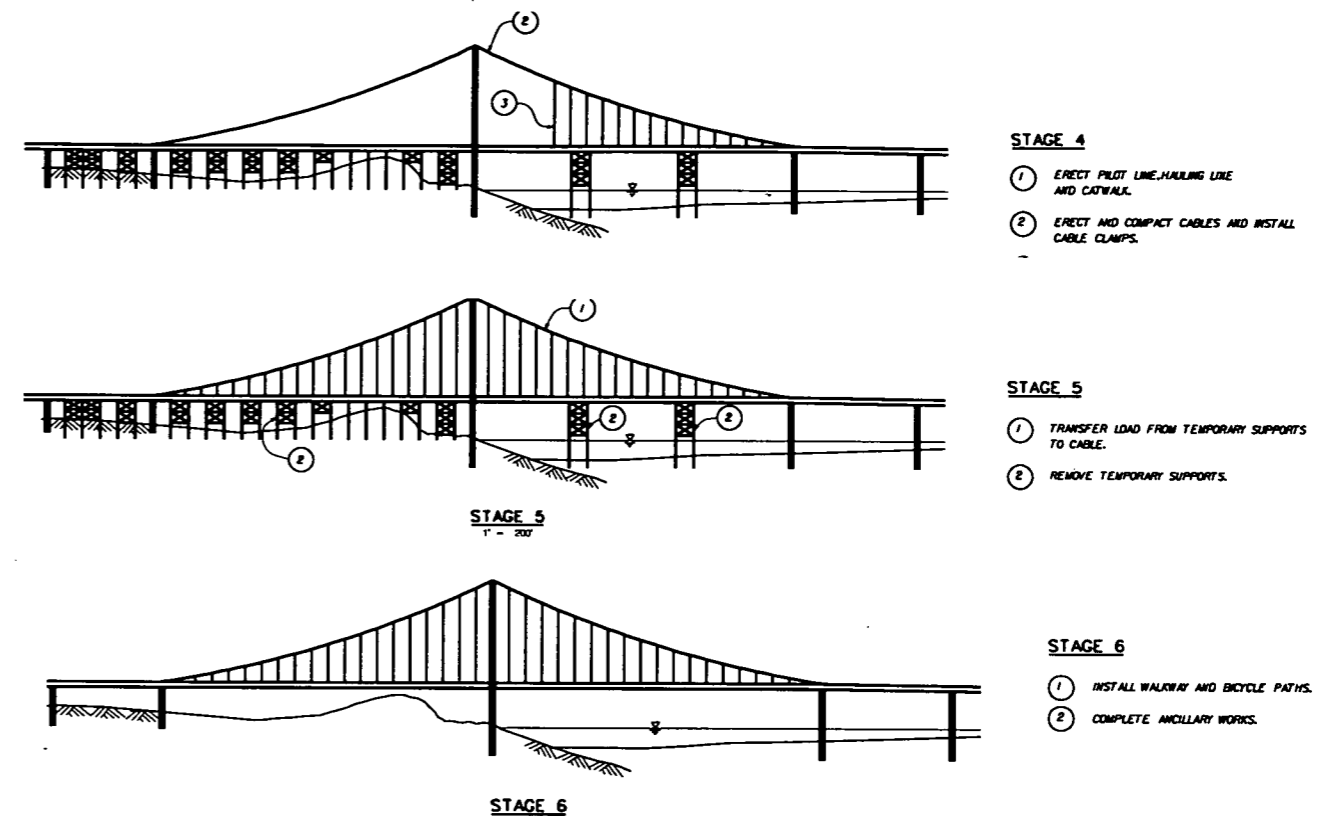
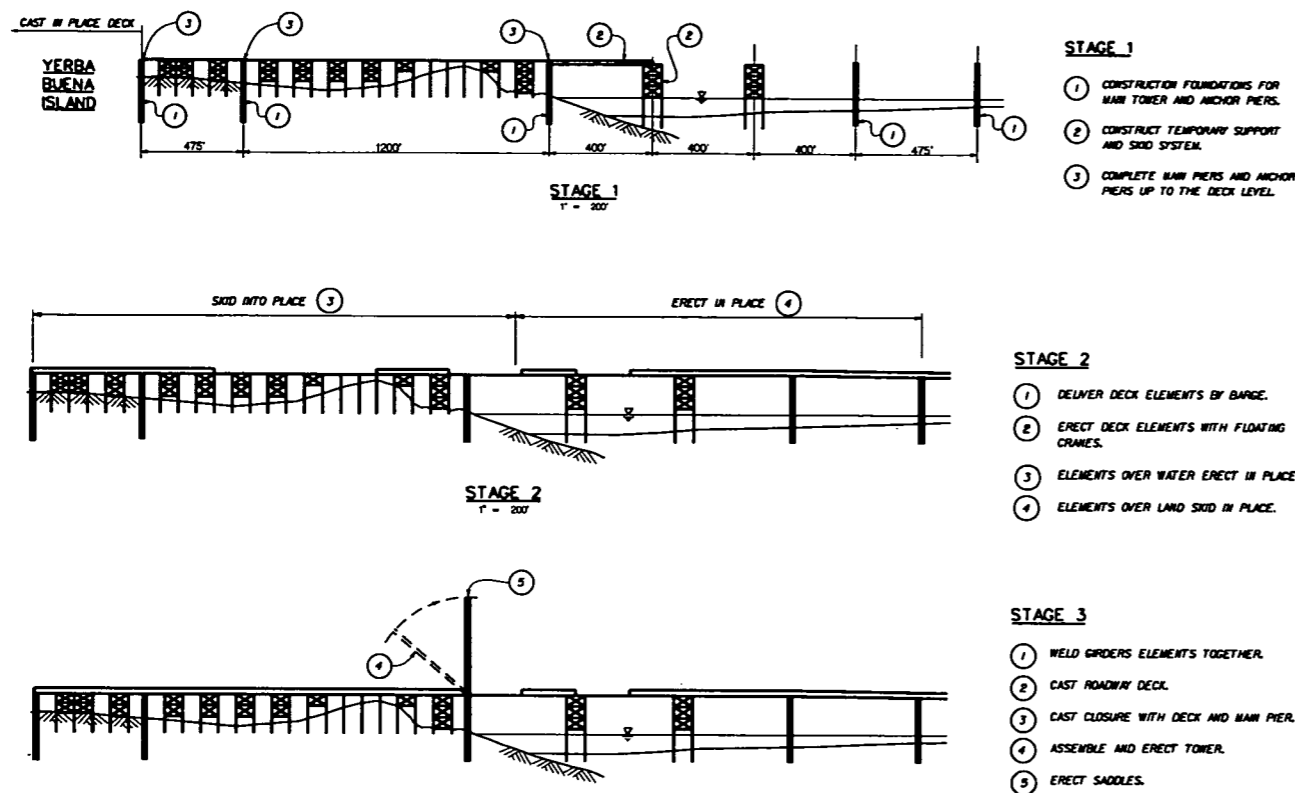
The approach structure will extend into shallow bay waters and will consist of concrete slabs supported on drop caps with 42-inch piling. Expansion joints will be located between two bents in such a way that each concrete deck is supported to eliminate a seat-type drop failure.

It is envisioned that the concrete column supported bents below the ramp will be covered with vertical or slightly tilted precast concrete side panels, in order to improve the aesthetics of the connection between the approach structure and the precast concrete viaduct spans.

TUNNEL ENTRANCE STRUCTURE

The necessity of maintaining traffic at all times coupled with the roadway width restrictions imposed by the tunnel require that a portion of the tunnel entrance structure remain. Approximately 300 feet of the tunnel approach will be seismically retrofitted and rehabilitated. During construction, this portion of the structure will be modified to allow traffic to be diverted to a temporary bridge placed to the south of the existing structure. This will allow the forward section of the existing bridge to be removed thus allowing the new bridge to line up with the axis of the tunnel.

It is envisioned that the required retrofitting will take place on the outside of the bridge to avoid disruptions to traffic.



CONSTRUCTION

Most of the new bridge alignment allows for floating access with a minimum water depth of 6 feet below MLLW. The Oakland approach viaduct and the first three spans however are located in relatively shallow water. For this sensitive wet land area the design of the structure will allow utilization of shallow water construction techniques which require the minimum use of dredging or filling.

Construction access for the 1800-ft. long pile-supported ramp structure will be from a steel and timber trestle located just north of the existing east approach. This trestle will allow the use of land based equipment and eliminate the need for access dredging.

Foundations for the first spans will utilize float-in-precast caps similar to the rest of the viaduct spans. The draft of these precast caps will be shallow enough to allow floating in and landing of the caps during the high tide cycle. Pile driving, tremie concrete placement and pier erection will all be performed from an extension of the access trestle used for the approach ramp.

The first three spans could then be constructed using any of the following techniques, none of which requires the use of marine equipment or access dredging:

- Cast-in-place on falsework installed from trestle
- Segmental precast erected with gantry crane over the top
- Incremental launching from east abutment.

All other viaduct spans and superstructure elements for the main suspension spans will be delivered by barge and erected using heavy lift marine cranes.

The design of both the suspension bridge and the Viaduct Bridge is based on full on-shore pre-fabrication in a controlled environment to facilitate quality assurance and a high quality product of both steel and concrete components. Cast-in-place operations in the field are limited to well prepared sections and details that can be readily inspected during construction.

The interior of the box girder for the suspension spans will be corrosion protected by dehumidification of the interior.



ENVIRONMENTAL

Design of the new span will be performed with sensitivity to environmental concerns and awareness of physical and cultural elements that may be at risk as a result of inappropriate design or construction actions.

Adverse impacts on wetlands in the Emeryville Crescent will be minimized by restricting the footprint of the affected area - generally favoring an alignment with a short path through the wetlands and using elevated spans rather than embankments, and by using design features which allow for free circulation below the structure from side to side of the roadway. Construction impacts will be mitigated by removal of the old span in a manner which allows for early recovery of wetland conditions in areas now occupied by the old span.

Both in the wetlands and in open water areas, any necessary bay fill and dredging will be associated with pier construction. These elements will be minimized by minimizing the number of piers (using the longest practical span lengths between piers) and by pier design which avoids massive "islands". Net bay fill will be further minimized by removing the piers of the old span down to or slightly beneath the mud line.

Dredge and fill procedures will be coordinated with the Four Agency Dredging Group (Corps of Engineers, Regional Water Quality Control Board, Bay Conservation and Development Commission, Environmental Protection Agency).

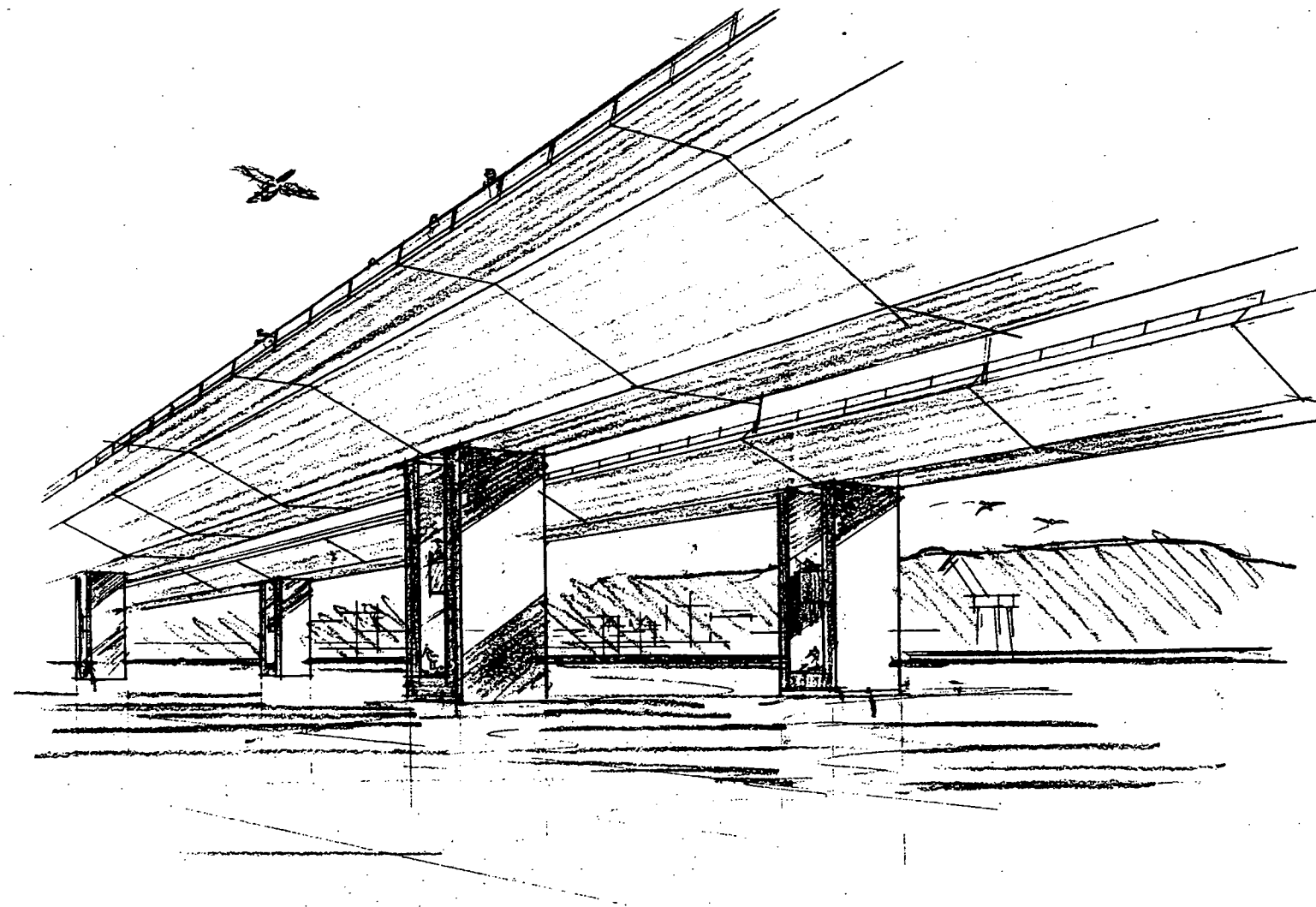
The potentially most sensitive wildlife features at risk include birds, fish, and harbor seals. Peregrine falcons and double-crested cormorants are known to nest on substructures of the Bay Bridge and the San Mateo Bridge. Design of the new east span will include substructure features that allow for continuation of such nesting, as well as for the cormorants' practice of "roosting and loafing" on bridge substructure. Further, plans for removal of the old structure will call for delaying the start of demolition until after that year's fledglings have left the nest. Least terns nest by preference on sandy beaches; the nearest known nesting areas are at Alameda Naval Air Station and Oakland Airport. Clapper rails nest in wetland cord grass, eel grass, and pickleweed, with the nearest known nesting areas north of San Pablo Bay and in south San Francisco Bay. Any indications of nesting of these two species in the area affected by the new span will be surveyed during the design process in consultation with the California Department of Fish and Game (DFG) and the Raptor Bird Center at U.C. Santa Cruz.

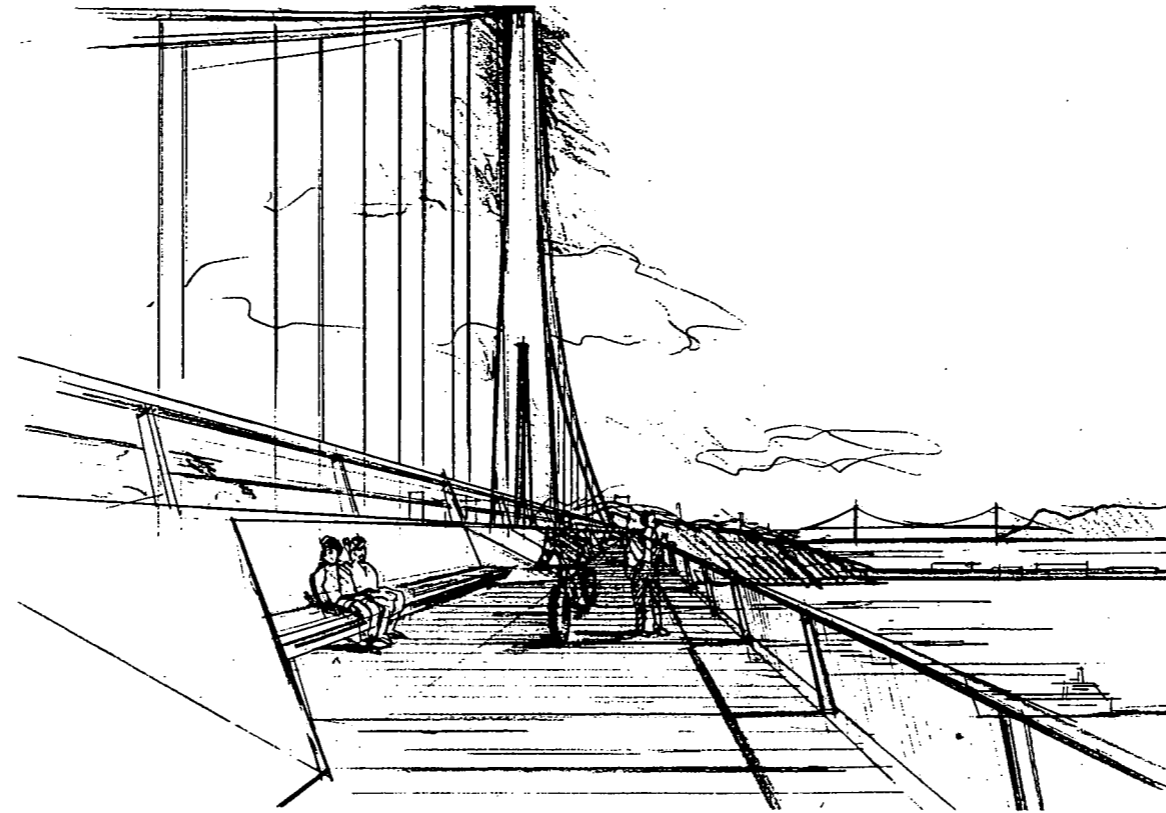


Potential impacts on Pacific herring and winter run Chinook salmon will be avoided by conforming to the December to March "no dredge window" set to protect the salmon, which would be at risk only from dredged material disposal since their migration path avoids the prospective pier locations.

The major hazard to harbor seals would be from activities affecting their haul-out and pupping areas. While these are generally away from the new span, surveys for any such areas will be conducted during design, in coordination with DFG.

Known and potential prehistoric and archaeological sites on Yerba Buena Island to be avoided in construction of bridge foundations will be identified in coordination with the Northwest Information Center at Sonoma State University, the main local consultant to the State Historical Preservation Office. Features already known to exist include a historic redwood retaining wall, remnants of an old jail and remains of several old cisterns, all at the eastern end of Yerba Buena Island. Design of foundations and ramps connecting the bridge to Yerba Buena Island will follow principles of aesthetic sensitivity and conformance to the natural setting that are hallmarks of sound, high quality engineering.





COMMUNITY

ENVIRONMENTAL

Users of the bridge will enjoy unparalleled panoramas of the bridge itself, the broad sweep of the bay, and the interactions of the bridge with the shorelines. Motorists will find their views ahead will be more open and their views to the sides unencumbered by the bridge and barrier structure. For the first time, motorists leaving the Yerba Buena Island tunnel and continuing along the span will enjoy an unimpeded view of the East Bay shoreline.

Cyclists and pedestrians will find themselves on continuous viewing platforms separated from the main traffic flow.

A temporary structure to the south of the existing span will allow for tie-in of the new bridge to the tunnel portal with almost uninterrupted flow of traffic.

The new bridge presents a modern, vibrant visual statement while blending smoothly into the visual theme of the major bridges of the bay. It gives the eastern span its own characteristic,

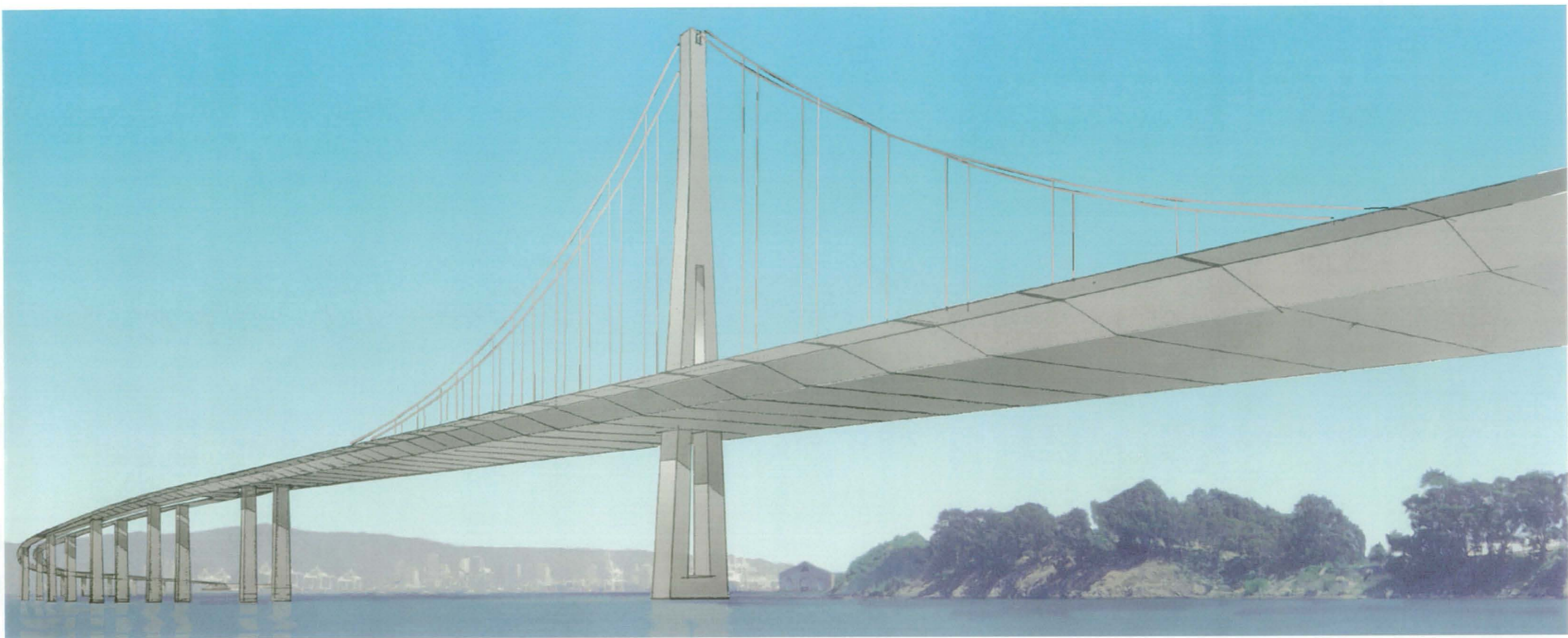
instantly recognizable appearance while conforming to, and complementing, the visual themes of the other structures.

First and foremost, the new span will meet all of the stated criteria- it will provide a high level of post-earthquake performance; it will provide the required traffic lanes and shoulders within the stated slopes and geometry; it will merge smoothly with the tunnel and toll plaza, provide access to YBI, and provide for the specified navigation channel. Further, it meets these goals with sensitivity to visual, aesthetic, and environmental concerns.

We believe it is an elegant solution.

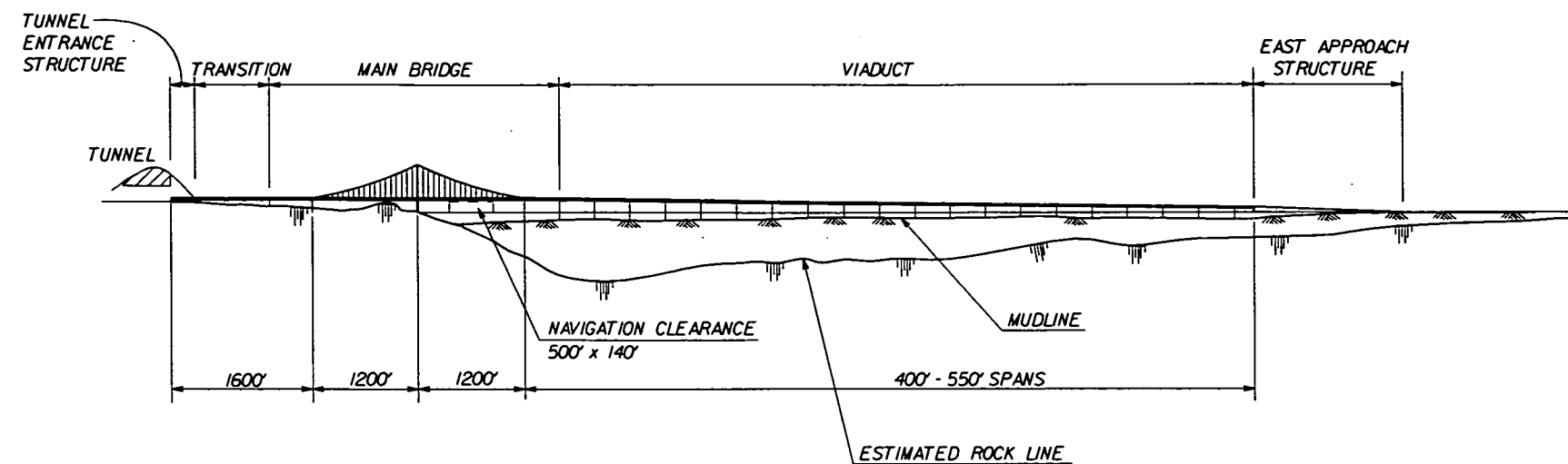
PEDESTRIAN-BIKEWAY LANE

Potential provision of two-way pedestrian-bikeway has been allowed for.

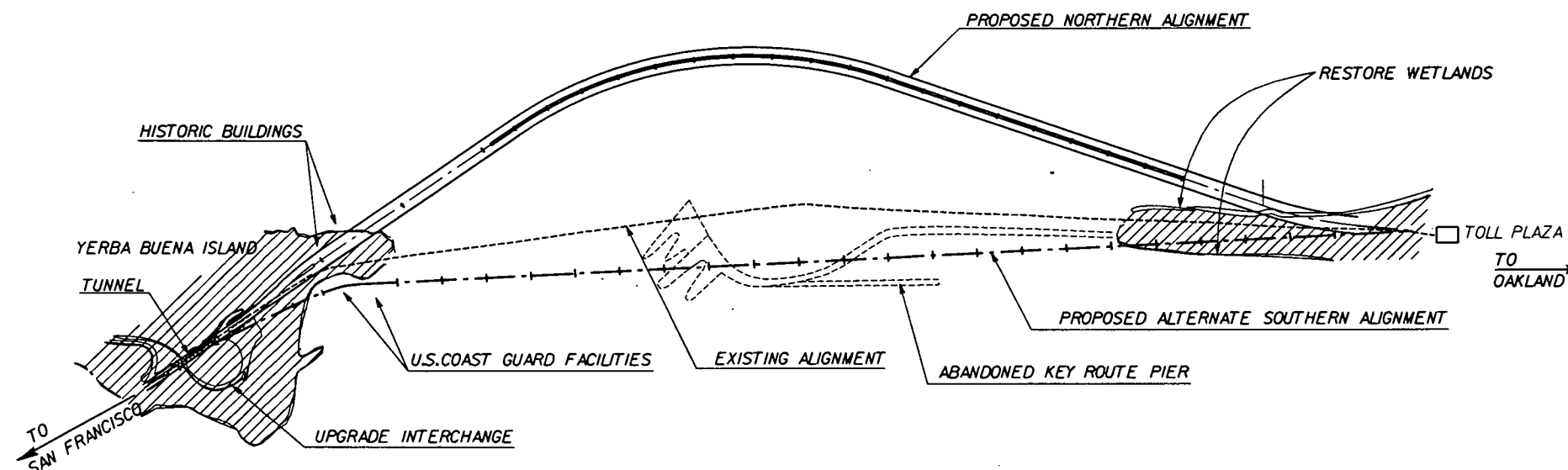








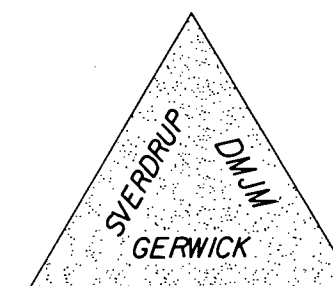
VERTICAL ALIGNMENT



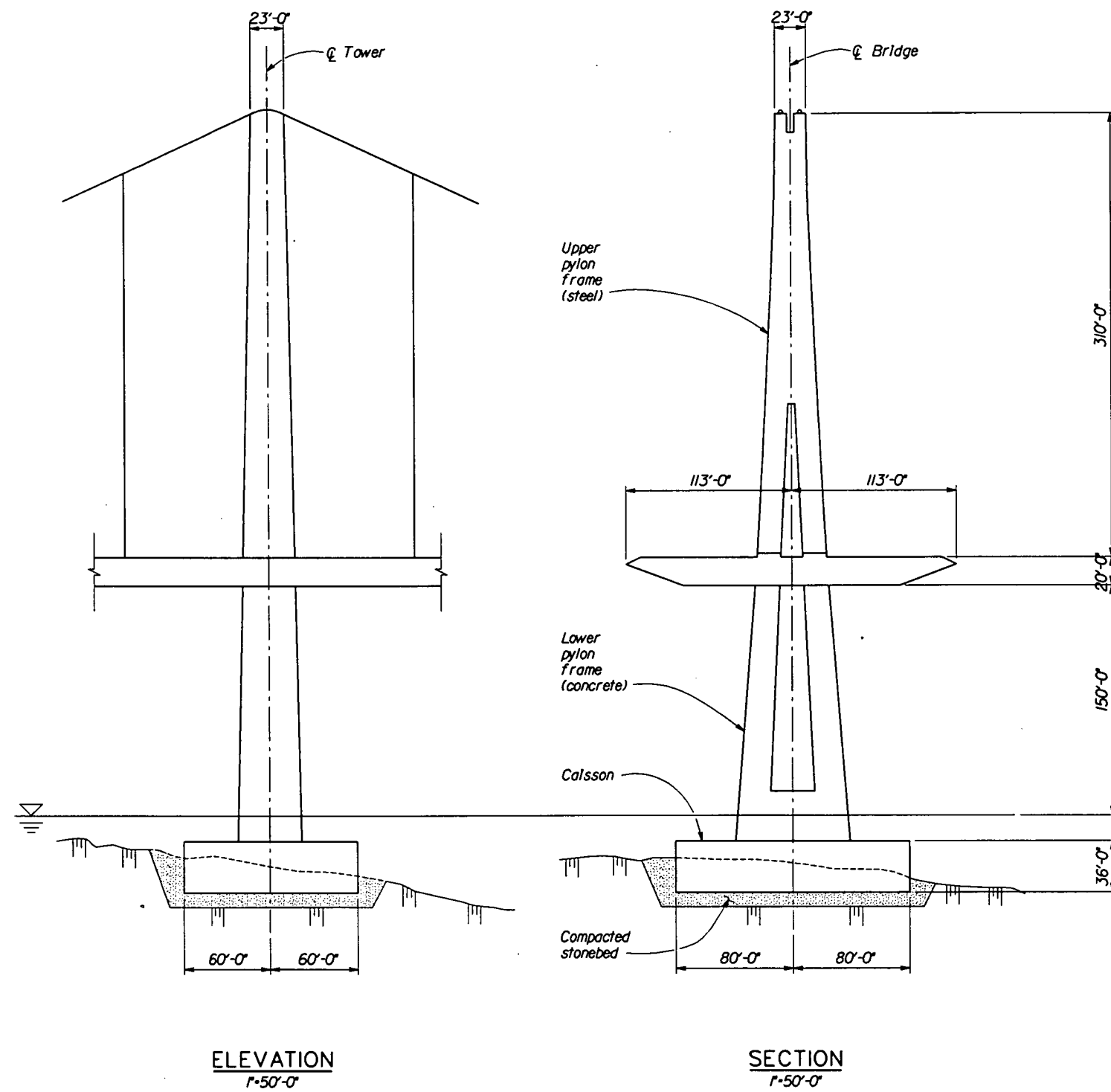
HORIZONTAL ALIGNMENT

EAST BAY BRIDGE REPLACEMENT

SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL

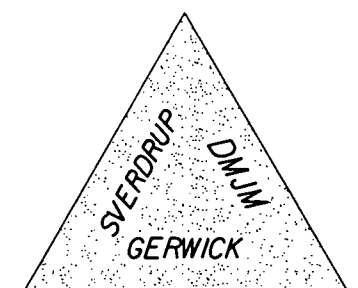


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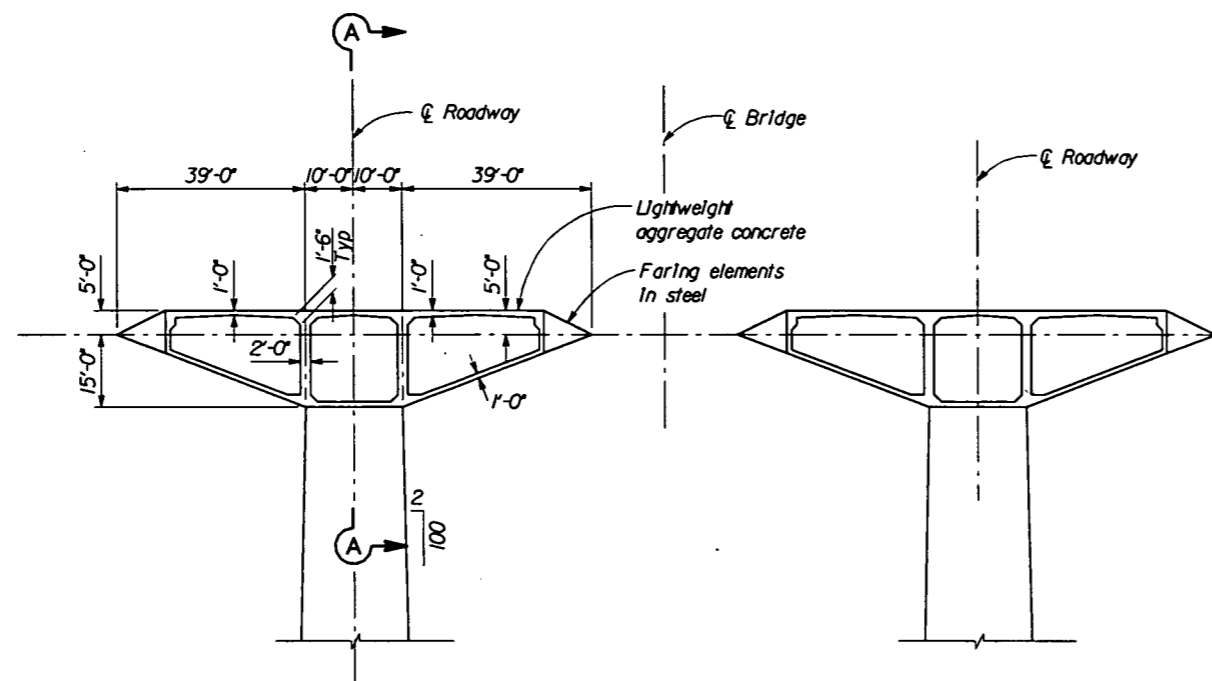


EAST BAY BRIDGE REPLACEMENT

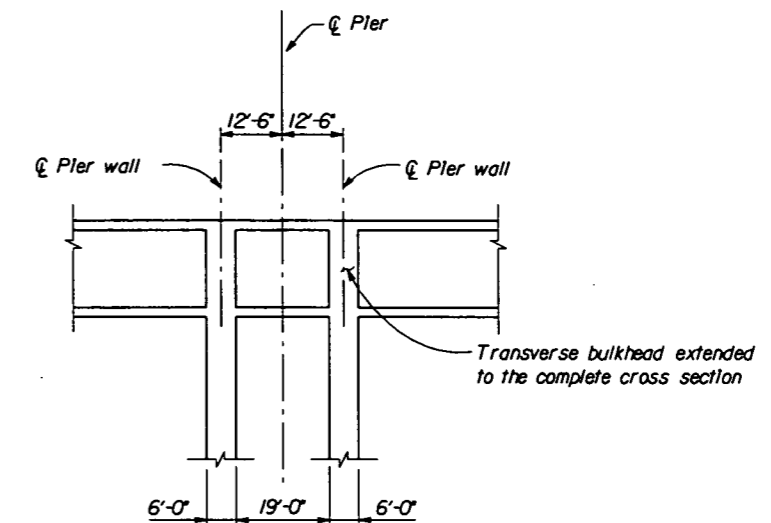
SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



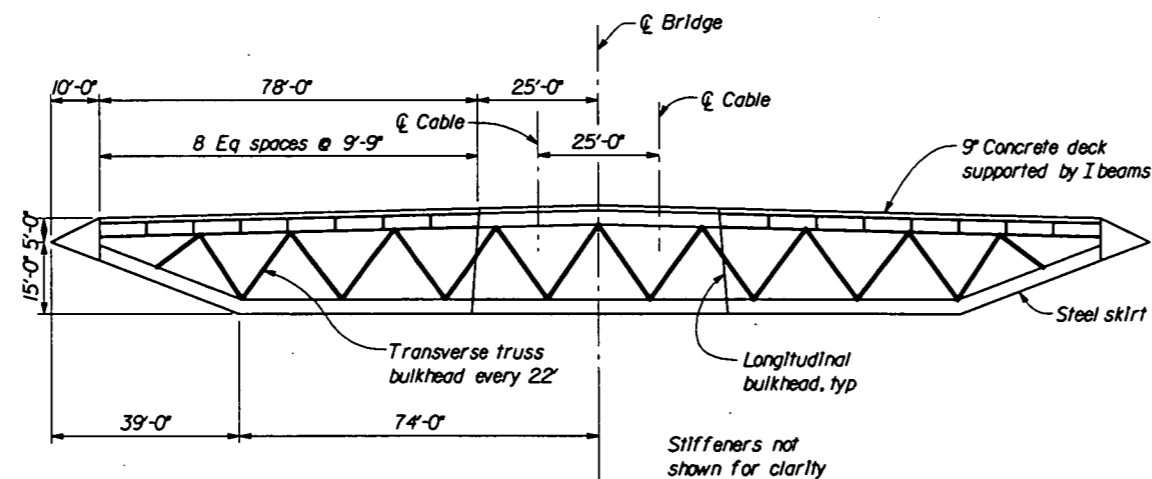
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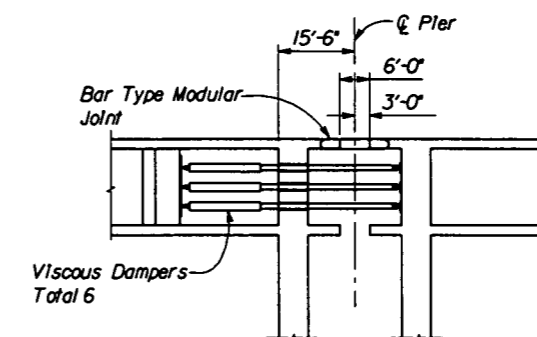
VIADUCT BRIDGE CROSS SECTION
1" = 20'



SECTION A-A
1" = 20'



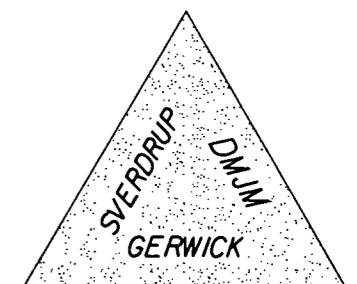
MAIN BRIDGE CROSS SECTION
1" = 20'



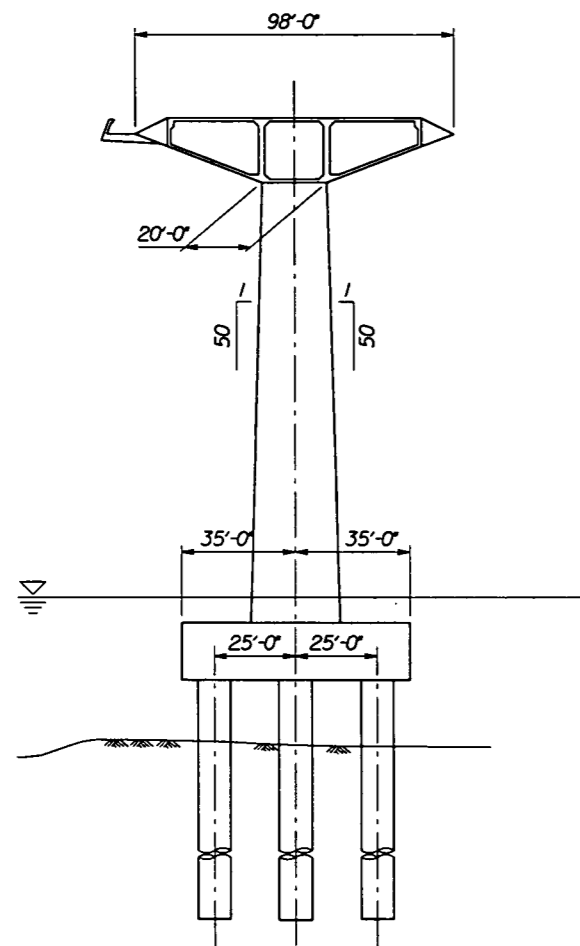
SECTION A-A AT EXPANSION PIER
1" = 20'

EAST BAY BRIDGE REPLACEMENT

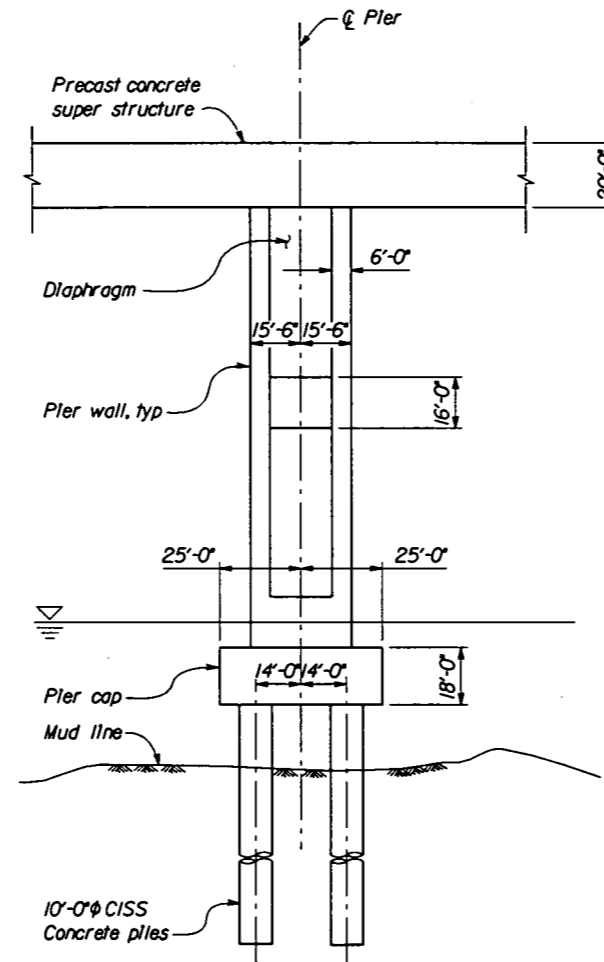
SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



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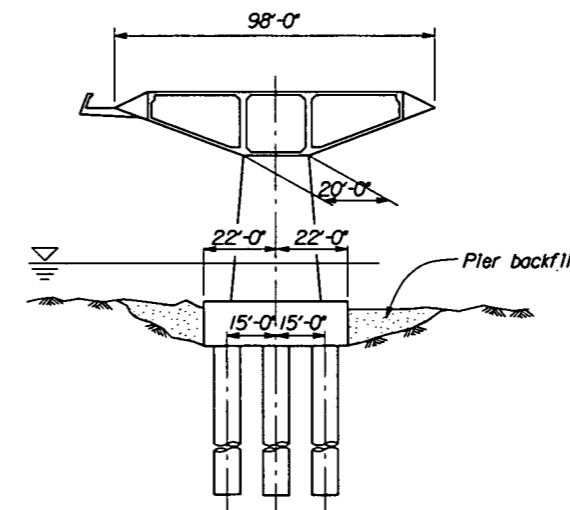


SECTION
1'-30'-0"

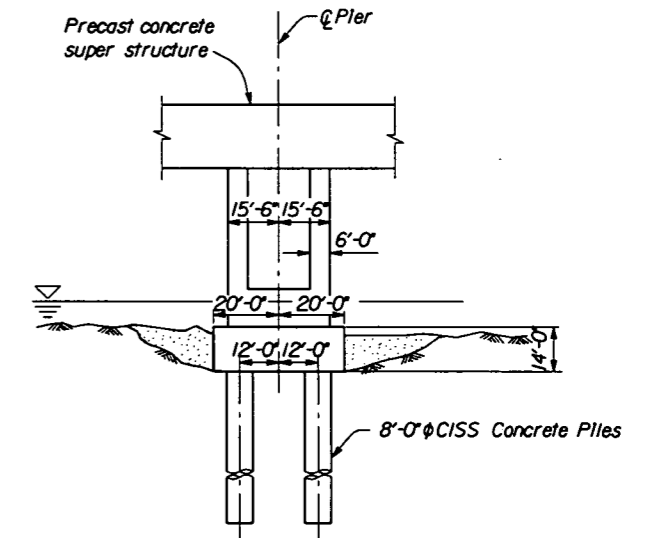


ELEVATION
1'-30'-0"

TYPICAL TALL VIADUCT PIER



SECTION
1'-30'-0"

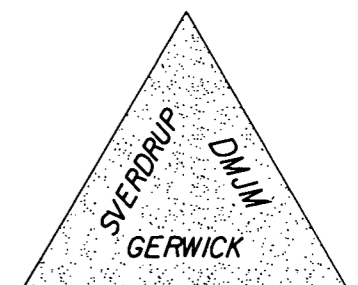


ELEVATION
1'-30'-0"

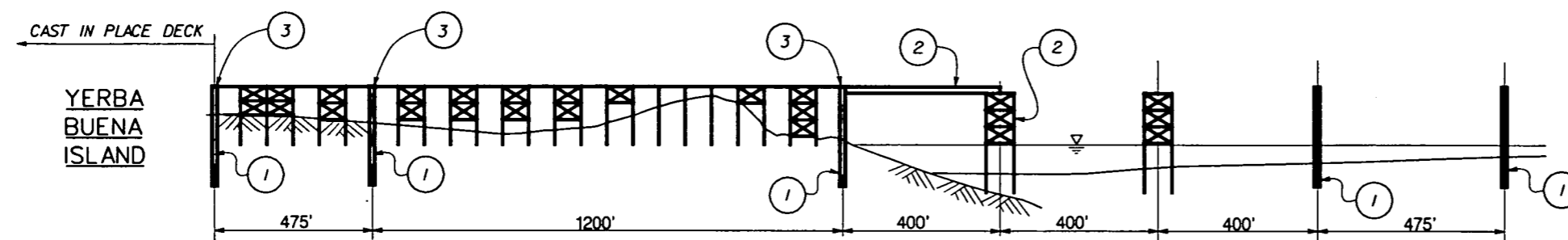
TYPICAL SHORT VIADUCT PIER

EAST BAY BRIDGE REPLACEMENT

SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



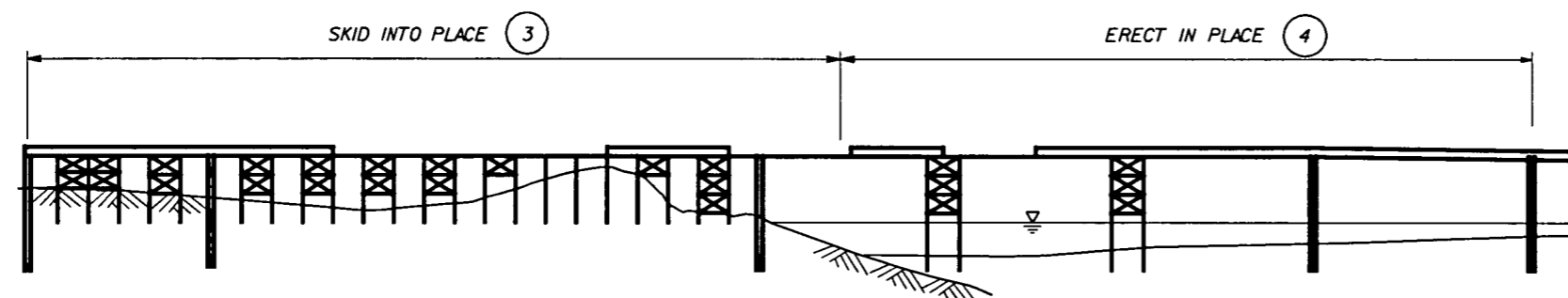
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STAGE 1
1" = 200'

STAGE 1

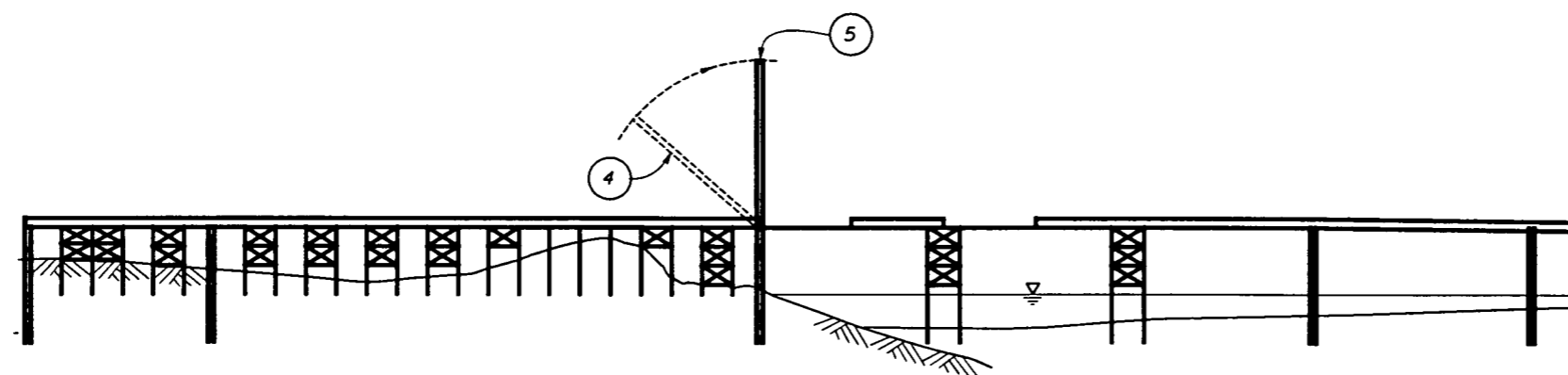
- ① CONSTRUCTION FOUNDATIONS FOR MAIN TOWER AND ANCHOR PIERS.
- ② CONSTRUCT TEMPORARY SUPPORT AND SKID SYSTEM.
- ③ COMPLETE MAIN PIERS AND ANCHOR PIERS UP TO THE DECK LEVEL.



STAGE 2
1" = 200'

STAGE 2

- ① DELIVER DECK ELEMENTS BY BARGE.
- ② ERECT DECK ELEMENTS WITH FLOATING CRANES.
- ③ ELEMENTS OVER WATER ERECT IN PLACE.
- ④ ELEMENTS OVER LAND SKID IN PLACE.



STAGE 3
1" = 200'

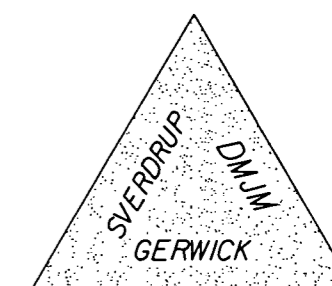
STAGE 3

- ① WELD GIRDERS ELEMENTS TOGETHER.
- ② CAST ROADWAY DECK.
- ③ CAST CLOSURE WITH DECK AND MAIN PIER.
- ④ ASSEMBLE AND ERECT TOWER.
- ⑤ ERECT SADDLES.

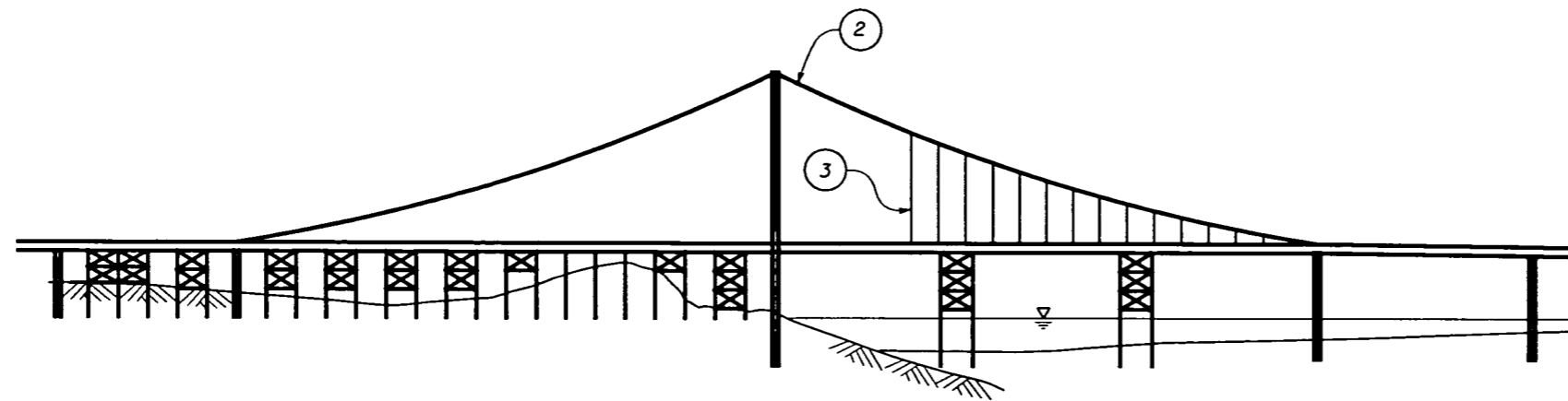
MAIN BRIDGE CONSTRUCTION SEQUENCE

EAST BAY BRIDGE REPLACEMENT

SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



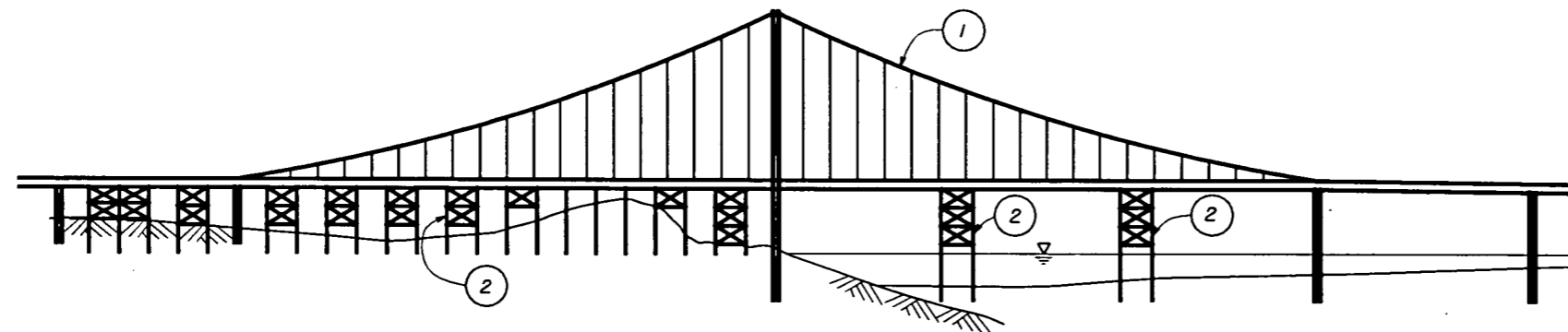
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STAGE 4
1" = 200'

STAGE 4

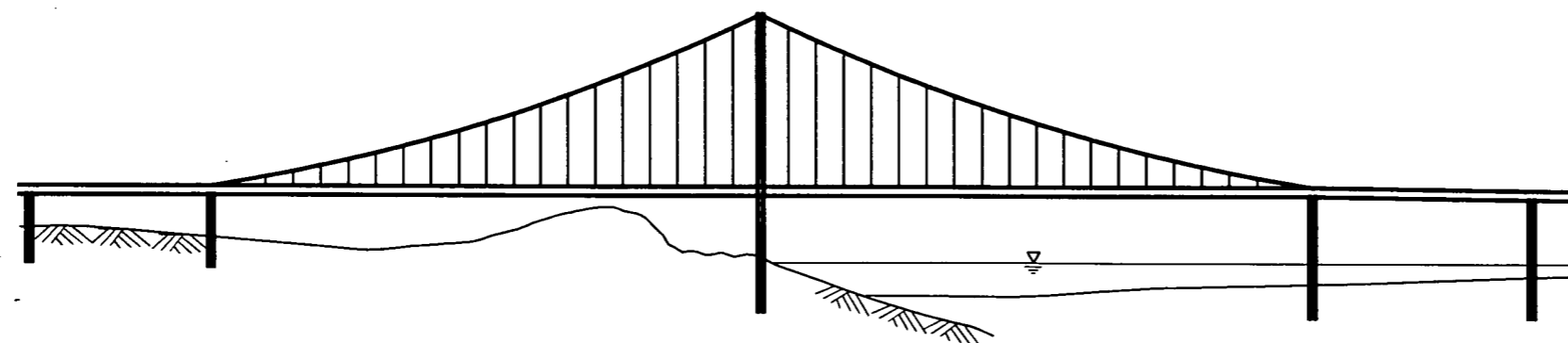
- ① ERECT PILOT LINE, HAULING LINE AND CATWALK.
- ② ERECT AND COMPACT CABLES AND INSTALL CABLE CLAMPS.
- ③ ERECT HANGER CABLES.



STAGE 5
1" = 200'

STAGE 5

- ① TRANSFER LOAD FROM TEMPORARY SUPPORTS TO CABLE.
- ② REMOVE TEMPORARY SUPPORTS.



STAGE 6
1" = 200'

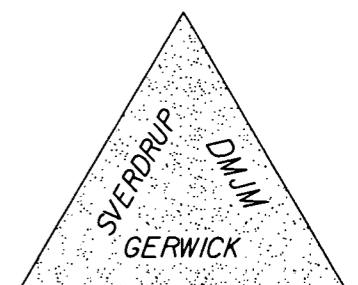
STAGE 6

- ① INSTALL WALKWAY AND BICYCLE PATHS.
- ② COMPLETE ANCILLARY WORKS.

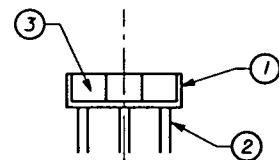
MAIN BRIDGE CONSTRUCTION SEQUENCE

EAST BAY BRIDGE REPLACEMENT

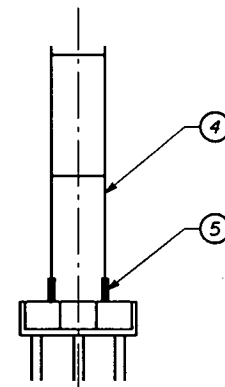
SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



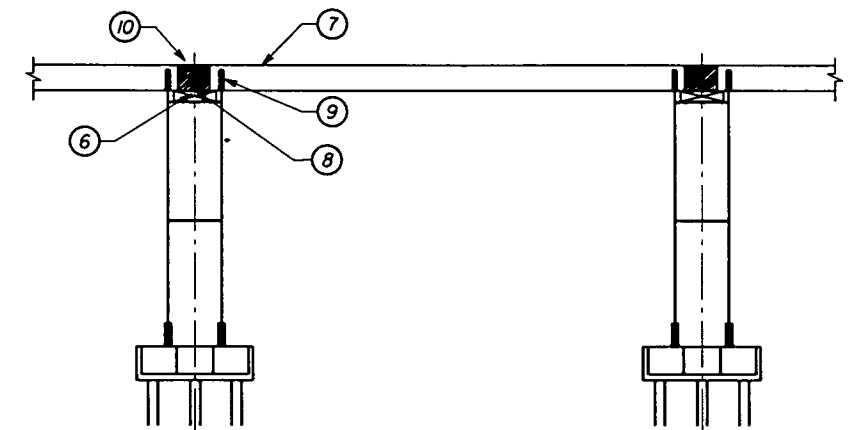
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- ① FLOAT IN PRECAST CONCRETE CAP
- ② DRIVE STEEL PIPE PILE THROUGH PRECAST CONCRETE CAP
- ③ CONNECT STEEL PIPE PILE TO PRECAST CONCRETE CAP USING TREMIE SEAL, REBAR CAGES AND SUPER PLASTISIZED CONCRETE



- ④ ERECT PRECAST CONCRETE PIERS USING HEAVY LIFTING EQUIPMENT
- ⑤ CONNECT PIERS TO CAP WITH CAST-IN-PLACE CLOSURE POUR

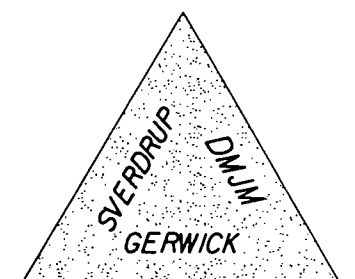


- ⑥ INSTALL TEMPORARY SUPPORTS ON HYDRAULIC JACKS ACROSS THE PIERS
- ⑦ ERECT SUPERSTRUCTURE GIRDERS USING HEAVY LIFTING EQUIPMENT
- ⑧ LEVEL THE GIRDER USING THE TEMPORARY SUPPORT JACKS
- ⑨ CONNECT THE GIRDERS TO THE PIERS THROUGH CLOSURE POURS
- ⑩ CONNECT THE GIRDERS ACROSS THE PIERS THROUGH HORIZONTAL CLOSURE POURS

VIADUCT BRIDGE CONSTRUCTION SEQUENCE

EAST BAY BRIDGE REPLACEMENT

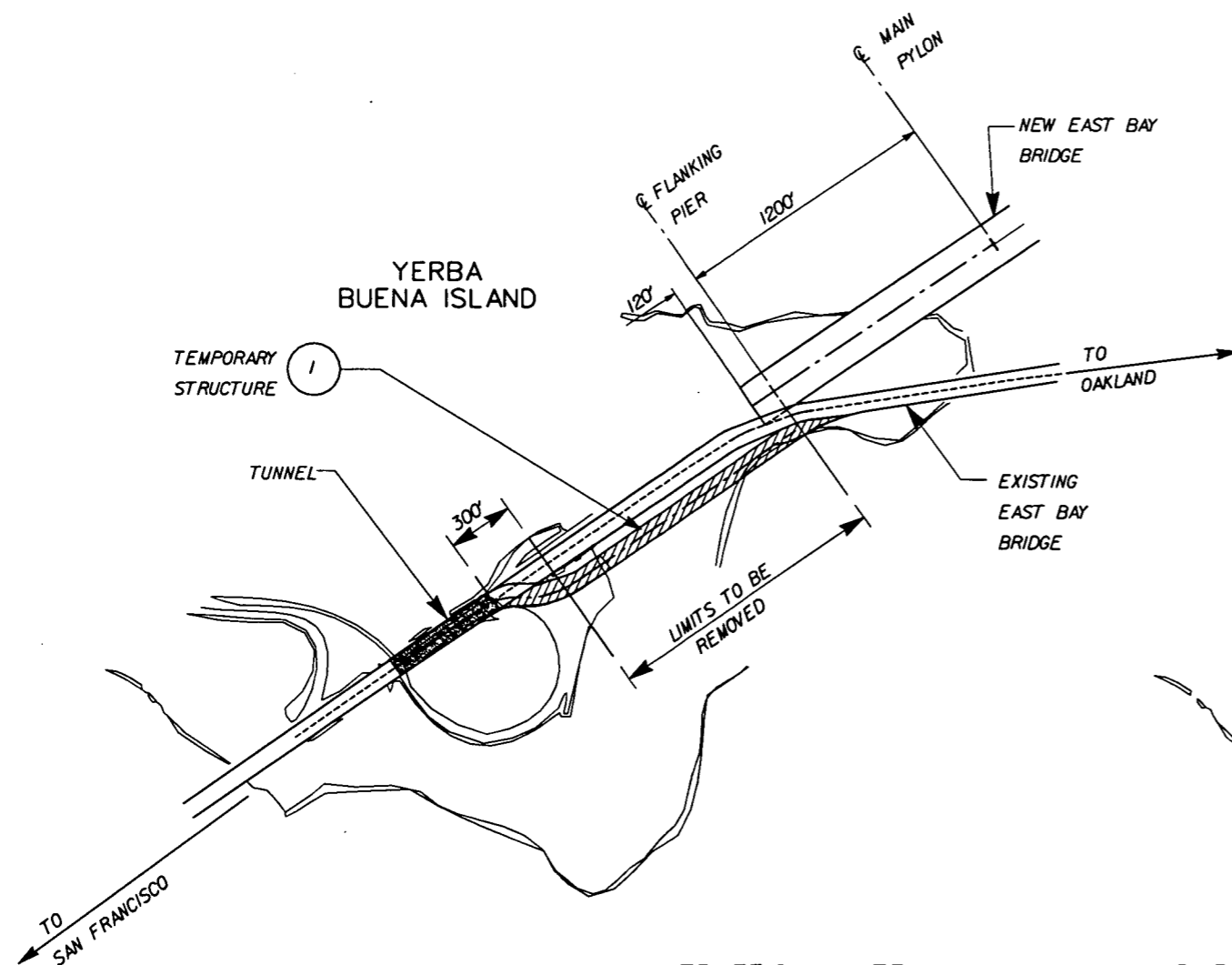
SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



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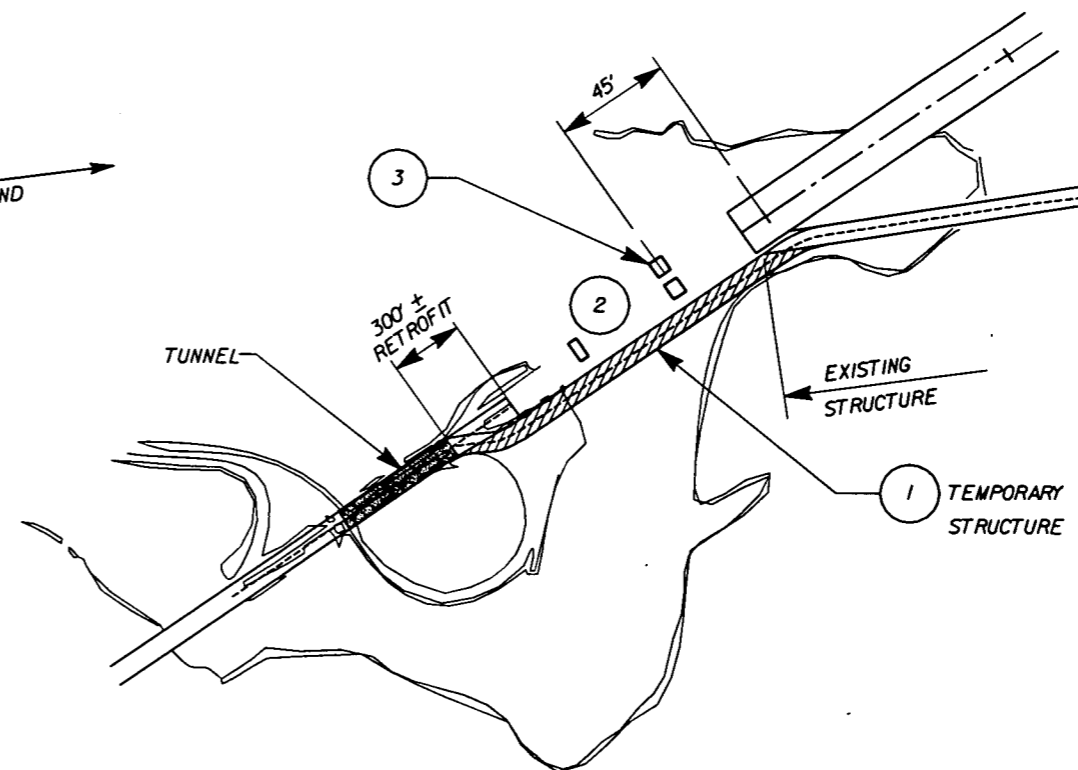
STAGE 1

- ① CONSTRUCT TEMPORARY ACCESS.
- ② CONSTRUCT MAIN SPAN AND 120' OF FLANKING SPAN.



STAGE 2

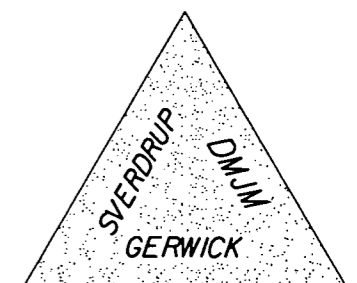
- ① RE-ROUTE TRAFFIC TO TEMPORARY ACCESS SPAN.
- ② DEMO OLD SPAN AND RETROFIT FIRST 300 FT OF EXISTING STRUCTURE FROM TUNNEL.
- ③ CONSTRUCT FOUNDATIONS FOR NEW TRANSITION INTO YERBA BUENA TUNNEL.



TRAFFIC MAINTENANCE AT YERBA BUENA ISLAND

EAST BAY BRIDGE REPLACEMENT

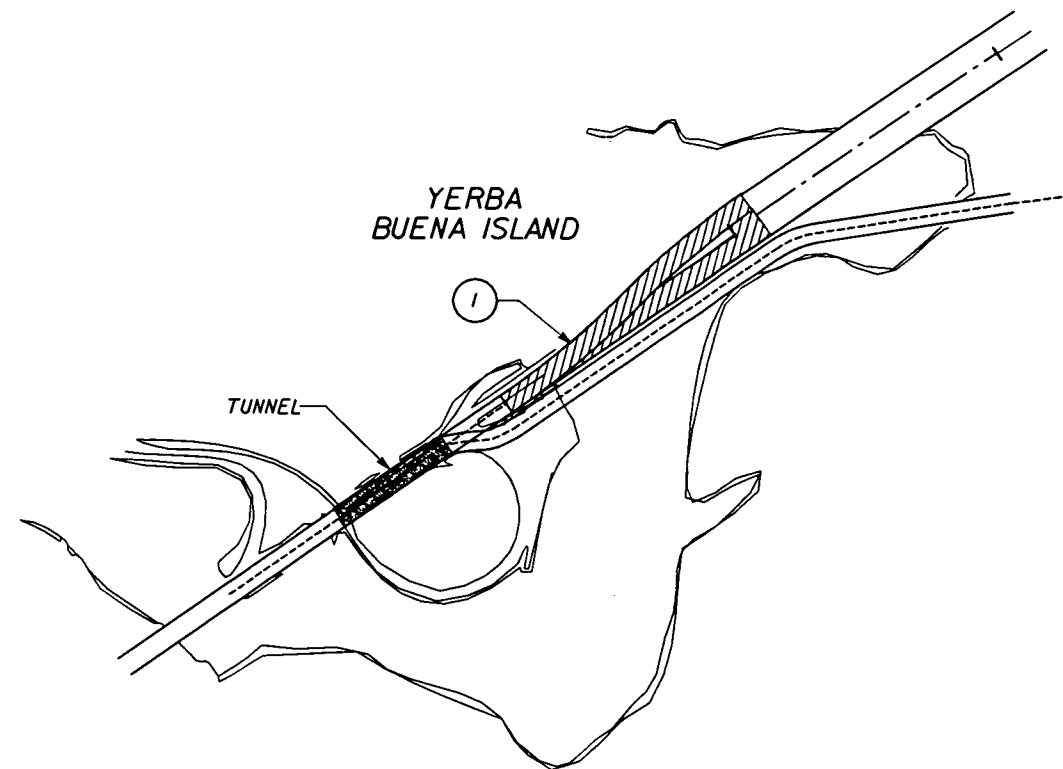
SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



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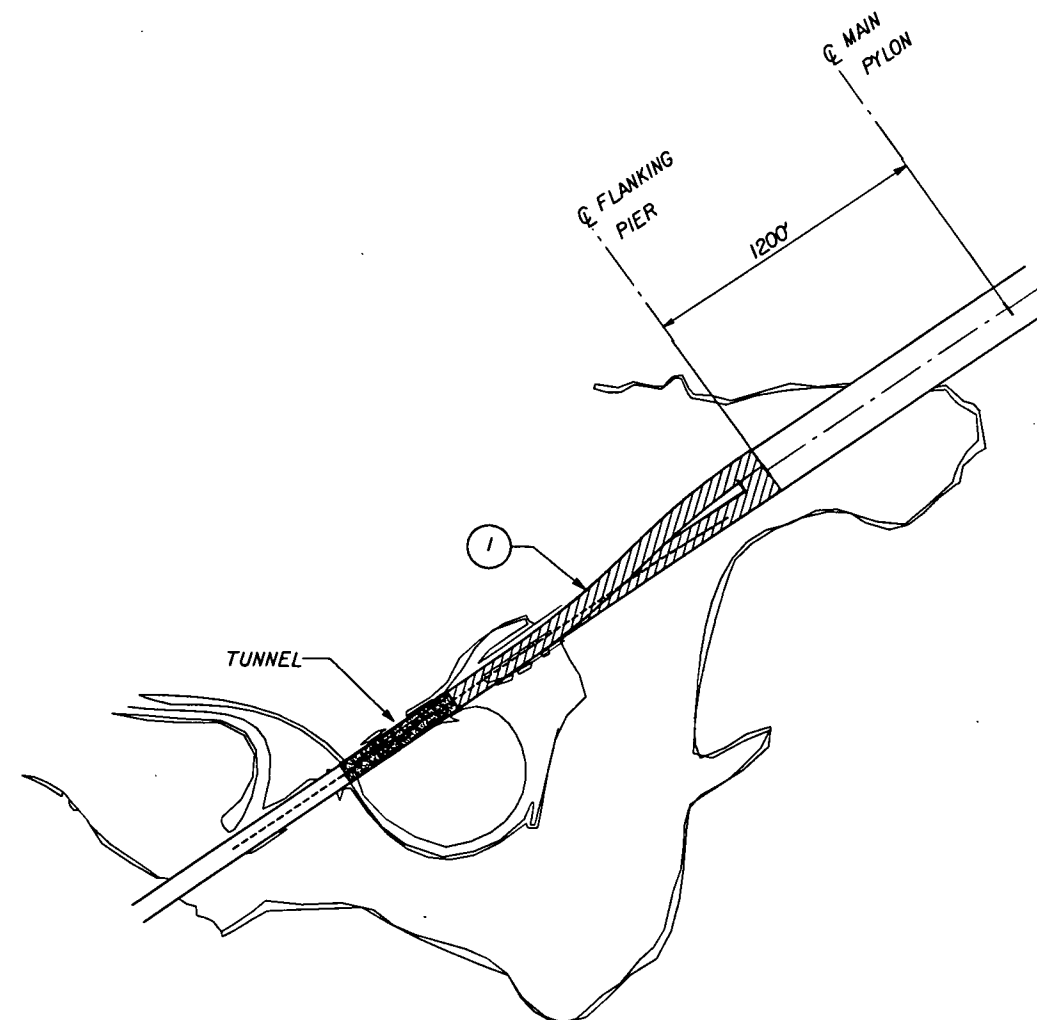
STAGE 3

- ① CONSTRUCT TRANSITION INTO YERBA BUENA TUNNEL



STAGE 4

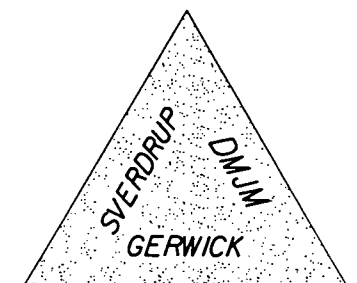
- ① RE-ROUTE TRAFFIC TO NEW TRANSITION ON TO NEW BRIDGE.
- ② DEMO TEMPORARY TRANSITION.



TRAFFIC MAINTENANCE AT YERBA BUENA ISLAND

EAST BAY BRIDGE REPLACEMENT

SELF-ANCHORED SUSPENSION BRIDGE AND TWIN VIADUCT PROPOSAL



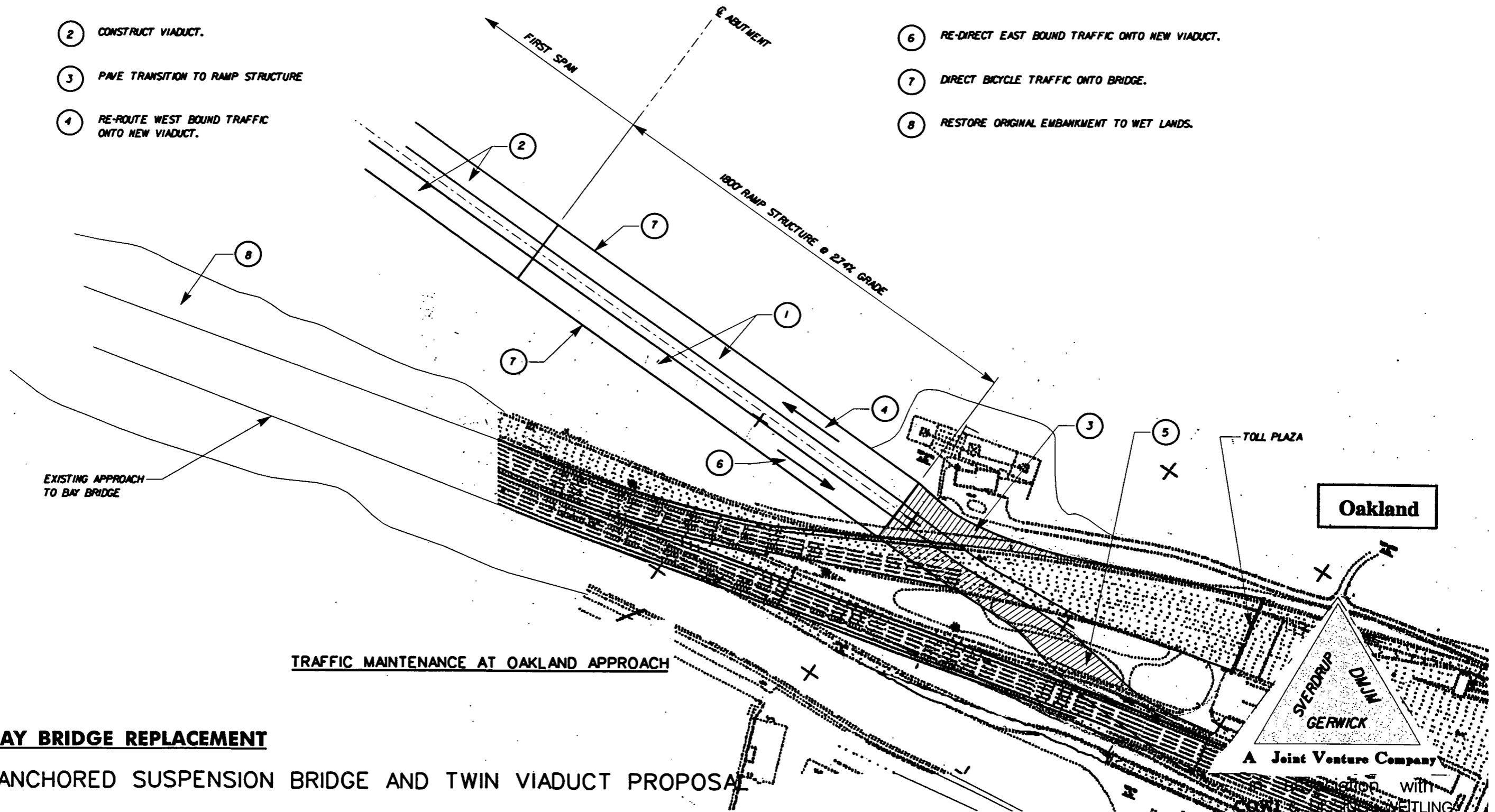
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STAGE 1

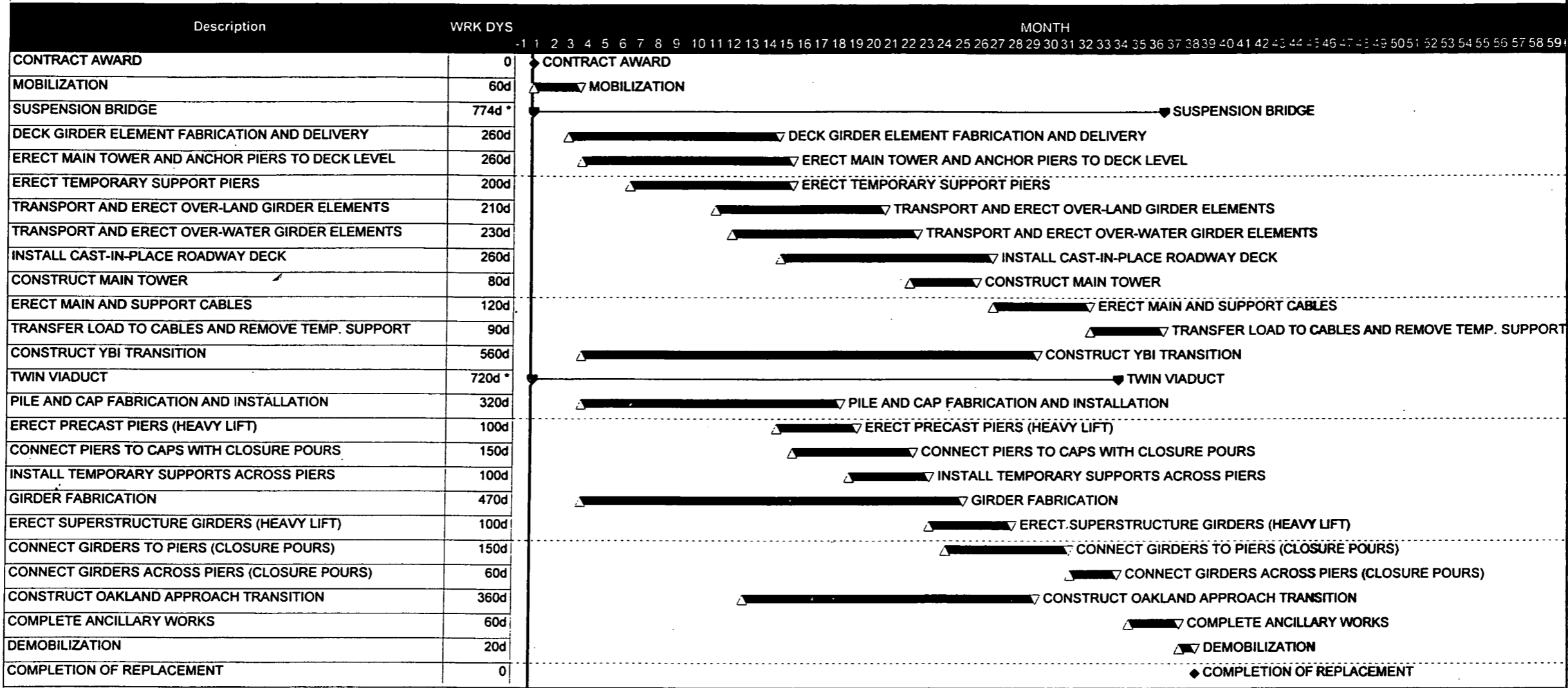
- ① CONSTRUCT RAMP STRUCTURE.
- ② CONSTRUCT VIADUCT.
- ③ PAVE TRANSITION TO RAMP STRUCTURE
- ④ RE-ROUTE WEST BOUND TRAFFIC ONTO NEW VIADUCT.

STAGE 2

- ⑤ RE-PAVE AND STRIPE EAST BOUND TRANSITION.
- ⑥ RE-DIRECT EAST BOUND TRAFFIC ONTO NEW VIADUCT.
- ⑦ DIRECT BICYCLE TRAFFIC ONTO BRIDGE.
- ⑧ RESTORE ORIGINAL EMBANKMENT TO WET LANDS.



EAST BAY BRIDGE REPLACEMENT
PRELIMINARY CONSTRUCTION SCHEDULE



Company name	Ben C. Gerwick, Inc.
Project title	East Bay Bridge Replacement
Run date	09MAY97
Page number	1A
Number/Version	01
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Box 9, Folder 3

Item 6

ACCNO_001098